Examination Papers for Civil Engineers before the New York Municipal Service Examining Board.

(*Continued from page, 18.*)

Examination of Applicants for Position of Transitman.

ARITHMETIC.

1. $\frac{3}{5}$ of an inch is what decimal fraction of a yard?
2. $36 is 15% of what sum?
3. Find the square root of 2.2201?
4. Say a few words about the French metric system?

MATHEMATICAL GEOGRAPHY.

1. Suppose a vessel at sea finds that the chronometer indicates 9.30 A.M., New York time, while the true time of the ships meridian is noon. New York is in longitude 74 degrees West, what is the vessel's longitude?

ALGEBRA.

1. Find the value of x in this equation?

$$\frac{x-1}{2}+\frac{x-2}{3}-\frac{x-3}{4}=6.$$

GEOMETRY.

1. The sum of the angles of a triangle is equal to what? Prove.
2. How can you find the center of a circle whose circumference shall pass through three given points?
3. Angle $A\,B\,C$ is thirty degrees. What is size of angle $A\,D\,C$? $A\,E\,C$? (Need not prove.)

MENSURATION.

1. The radius of a circle is 31 feet. What is the length of circumference and what the area contained?
2. What is the volume of a prismoid whose attitude is 18 feet, the dimensions of the upper base being 4 feet by 6 feet, and of the lower base, 5 feet by 8 feet?

TRIGONOMETRY.

1. Find in tables the natural and also the logarithmic cosine of 63° 50' 20."

PHYSICS.

1. Define these terms: Mass, Density, Weight, Inertia, Capillarity, Malleability?
2. Define latent heat and specific heat.
3. Define—Center of Gravity, Stability, Instability.
4. Which falls faster, one pound or two pounds, and why?
5. Describe the Barometer.

SURVEYING.

1. What is the true meridian? What are the different variations to which the magnetic needle is subject? What is local attraction, and how is it obtained, when noticed?
2. Describe a Vernier.
3. How would you determine the area of an irregular ten sided farm survey?
4. What is a traverse? What are its uses? What is the closing line?
5. Required to determine altitude of mountain on far side of impassable ravine. A sight is taken to top of mountain. Bearing is due North, angle of elevation is 45°; a line is run from this point of observation N. 60° E. 2200 feet. From end of this line, top of mountain bears due West, what is the altitude?
6. The difference in direction between two consecutive tangents of a railroad preliminary survey is 20°. It is required to connect these with a 5° curve (radius = 1145. 9 feet). Calculate the distance from point of intersection to point of curvature. (Logarithmic tables may be used).
7. Describe adjustment of engineer's level?
8. Earthwork Computation—Calculate quantity of earth in the railroad solid 100 feet long, the remaining dimensions of which are as follows:

Station	Center	Left	Right
		10.6	4.0
A	5.2	19.6	13.0
		9.1	7.3
B	8.0	18.1	16.3

Road-bed width = 18 feet.

MASONRY.

1. Give the classification of Masonry.
2. Define these terms: Facing, Backing, Filling, Irregular, Coursing, Bed-joints, Coping, Header, Stretcher, Pointing.
3. What precautions are necessary in laying masonry?
4. Mortar.—What is mortar? Grout? Common Mortar? Hydraulic Mortar?

IRON.

1. Name the different kinds of iron. Describe the qualities and uses of each.

STRENGTH OF MATERIALS.

1. Name the different kinds of strains to which building materials are subject.

HYDRAULICS.

1. How would you determine the quantity of water carried by a river past a certain point in a day?
2. What is an impounding reservoir? What is a distributing reservoir? What are the uses of each?

Examination of Applicants for position of Leveller.

ARITHMETIC.

1. Reduce $\frac{\frac{3}{4}\times\frac{4}{7}}{\frac{11}{12}\times\frac{3}{4}\div\frac{4}{7}}$ to a decimal fraction.

2. Add 2.006 + .00004; subtract from the sum .00451; multiply the remainder by 700.06 and divide the product by .032.
3. Two rectangles have equal areas; the dimensions of the first are 496 ft. and 84 ft. The length of the second is 812 ft., what is its width?
4. 3 yds. 2 ft. 10 in. is 18% of how many yds., ft., in?
5. What is the interest of $960.00 for 7½ months at 4% per annum?

MATHEMATICAL GEOGRAPHY.

Suppose that the chronometer of a vessel at sea indicates 8—45 A.M. New York time, while the true time of the ship's meridian is 11 A.M. New York is in longitude 74° West, what is the vessel's longitude!

ALGEBRA.

Find value of x in this equation:

$$\frac{x-8}{12}-\frac{x-5}{8}+\frac{x+11}{4}=\frac{x}{4}$$

GEOMETRY.

1. The sum of the angles of a triangle is equal to what? The square of the hypothenuse of a right-angled triangle is equal to what? Need not prove.
2. Define and make a sketch of two similar triangles.
3. How would you draw a tangent to a circle from a given point in the circumference?
4. What is a polygon; a trapezoid; a sector of a circle; a segment of a circle; a chord; an arc?

MENSURATION.

1. The radius of a circle is 19 ft. What is the length of the circumference and what the area contained?
2. What is the area of the top of a board 4 ft. wide at one end and 5 ft. wide at the other, the length being 18 ft?
3. What is the volume of a prismoid, whose altitude is 30 ft. the dimensions of the upper base being 5 ft. by 8 ft. and of the lower base 7 ft. by 12 ft?

TRIGONOMETRY.

Find in tables the natural and also the logarithmic cosine of ,39°, 45,' 40.

PHYSICS.

1. Define Centre of Gravity, Stability, Instability.
2. Which falls faster, one pound or two pounds, and why?
3. Define atmospheric pressure. Describe a syphon.
4. Describe a barometer. What are its uses in surveying?

SURVEYING.

1. Measurements. How should you chain up or down declivities?
2. Describe a vernier.
3. How would you calculate the area of an irregular farm survey?
4. Describe the adjustments of the Engineer's level.
5. In running a line of levels, what precautions must be observed with reference to the comparative lengths of foresights and backsights, and why?
6. What are contour lines? How are they taken? with what object?
7. Earthwork Computation—Calculate the quantity of earth in the railroad solid 100 ft. long, the remaining dimensions of which are as follows.

Station	Center	Left	Right
		10.6	6.2
A	7.1	19.6	15.2
B	11.4	12.3	8.5
		21.3	17.5

The nos. *over* horizontal lines indicate the elevations of the slope stakes above grade. The nos. *under* the horizontal lines indicate distances of the slope stakes from the center stakes. Road-bed width is 18 feet.

MASONRY.

1. Mention a few kinds of stone suitable for building purposes. What are the requisites for a good building stone?
2. Give the classification of masonry.
3. Define these terms: facing, backing, filling, bed joints, coping, header, stretcher, batter, pointing.
4. What precautions should be observed in laying masonry?
5. Mortar. What is mortar grout, common mortar, hydraulic mortar.

IRON.

What are the different kinds of iron? Describe the qualities and uses of each.

(TO BE CONTINUED.)

A CORRESPONDENT has devised a torpedo attachment for snow-plows, whereby, when a snow-plow is stalled in a heavy bank, a torpedo may be run out in advance eight to ten feet by means of a boom and exploded, thus clearing away the compacted snow, when the train

Plate Girder Bridges.*

BY M. J. BECKER, CHIEF ENGINEER, P. C. AND ST. L. R. R. CO.

My professional practice has been confined, almost exclusively, to Railroad Construction, and my practical experience is chiefly limited by the class of engineering peculiar to that service. What I may have to say, therefore, this evening, upon the subject under consideration, must be considered as applying more particularly to that branch of the profession with which I am most familiar.

Of course the general principles of all correctly designed mechanical structures are universal, although their application in detail may be varied by circumstances, and it is in the judicious and economical modifications of these universal principles, and in their proper adaptation to the different types of construction, where the skill of the engineer comes most prominently into play, and there is no branch of his professional practice in which the opportunities for the exercise of good judgment present themselves to better advantage than in the selection of proper designs for bridge superstructures suitable to serve the purposes for which they are intended.

Judging by what has already been accomplished in that direction, and by the boldness and magnitude of the gigantic enterprises still in progress, it seems as if indeed no necessity could arise that would not be met, no difficulties presented which would not be overcome.

But while the contemplation of these masterpieces of modern science may challenge our admiration and gratify our professional pride, and while the rare genius of the gifted few may rear these enduring monuments to immortalize their fame, it is by the conscientious, thoughtful and laborious providing for the daily necessities and comforts of civilized life, that the rank and file of the profession at large earn their daily bread.

The truth of the old saying, that "whatever is worth doing at all, is worth doing well," applies with special force to those numberless structures in daily use, upon which the great masses of people rely for their intercourse and means of communication, and upon whose strength and safety they must of necessity depend with implicit confidence. It is therefore very proper and quite important, that those who may expect to be placed in charge of their construction, should learn to understand thoroughly the theoretical principles governing their designs, as well as the quality and character of the materials of which they are composed, and of the workmanship entering into their manufacture and final erection.

The history of bridge construction is co-eval and co-extensive with the history of the human race, and the successive steps of its development mark the progress of civilization.

It would be interesting, if time did not prevent, to compare the few remaining crude and ill-shaped relics of our barbarian ancestors with the massive, ponderous superabundance of strength in the surviving monuments of early history, or with the purely classical structures that took form at the dawn of the Christian era, or to contrast the graceful and picturesque beauties of the middle ages with the variegated creations of our present day, many of which, it must be confessed, are monstrosities of frightful shape, conceived in sin and begotten in iniquity, patented though they may be. There is, however, by the grace of Providence, a compensation in the products of creative art as well as in natural selection, "the fittest will always survive!"

Among the surviving species of modern creation, there is one type particularly which maintains to this day, almost unimpaired, its original form. Its adaptation has become very extensive, and its favor has increased with its use, and that is the type of which I have been requested to say a few words to you this evening.

A favorite article of general usefulness is always characterized by cheapness, endurance, and simplicity of construction. These qualities are combined in the so-called plate girder bridge to such a remarkable extent, as to secure its almost exclusive adoption upon railways for spans ranging from 15 to 75 feet in length. For spans of less than 15 feet, solid rolled iron beams of equal strength are usually found more economical and equally durable, and for spans over 75 feet pin connected structures with open web systems are preferable for like reasons under ordinary circumstances.

The development of this type of bridge structure has not been a progressive one, as far as magnitude is concerned, the first ones ever built being in fact the largest ones ever attempted. The Conway Bridge, a single span of 400 feet in length, and the Brittania Bridge of two spans of 460 feet each, and two spans of 230 feet each, erected as early as 1848 and 1850, respectively, are the largest structures of their kind in existence. The model of the Conway bridge, and the experimental tests made to determine the proper form and dimensions of its members, alone cost over $33,000.00. The Victoria bridge, at Montreal, with its 25 spans of lengths, varying from 242 feet to 330 feet; the Ayr bridge, near Brotherton, with a span of 225 feet; the Trent bridge, with two

* Read before the Ohio Engineers and Surveyors' Society, at Columbus, O., January 13, 1885.

spans of 130 feet each, though remarkable structures all, are but imitations on a reduced scale of Robert Stephenson's gigantic original masterpiece.

Applying present prices of iron to the weights of these structures, we find that their cost would be fully twice as much as modern truss bridges of equal lengths could be built for this day.

Numerous structures of this type, varying in spans from 30 to 100 feet in length, are in existence to day at different places in England, some of which were manufactured as early as 1846 by Fairbairn, from Stephenson's designs. At first these bridges were built with top flanges of cast iron, generally in the shape of rectangular tubes, which form was selected to give internal stiffness to the structure; but wrought-iron soon displaced these cast-iron members, which had been found unreliable when subjected to the action of variable loads under rapid transit. Profiting by this experience the large tubular bridges at Conway and Bangor, in process of construction at this time, were built of wrought-iron thoroughout. Gradually the cell shaped flanges extending across the roadway from girder to girder, and forming a tube or tunnel throughout the length of the span, changed into a triangular shape for the upper flange, the girders no longer cross connected throughout but braced laterally at intervals only. The next step was the adoption of straight, flat plate iron bottom flanges, and finally the introduction of the T shaped flanges for top and bottom alike. While the shape of the flanges of the earlier plate girders was undergoing these gradual changes and modifications, from the original cross connected tubes to single cells for each girder, and finally to simple plates and angles, the webs were continued for some time in double and sometimes in triple sheets, either separated and forming so called box girders, or closely spaced and connected together by occasional filling pieces and rivets.

The form now generally in use is I shaped, symmetrical and exceedingly simple. The sectional areas in the upper and lower flanges are made equal, on the presumption that the resisting capacity of the gross section of the top flange against a compressive strain is about equal to the resisting capacity of the net area, (rivets deducted) of the bottom flange against tension. By this symmetrical distribution of the material the neutral axis is made co-incident with the line of gravity and the elements for determining the strength of the girders are very readily ascertained.

The web sheets are now always reduced to single plates, and these rarely require a greater thickness than one-half inch, even the largest now constructed.

The prevailing type of plate girder bridges of the present day may be briefly described as follows: The upper and lower flanges are composed of double angle irons, of such sectional areas as will entirely satisfy, if practicable, the stresses produced by the loads; although these stresses vary in the different parts of the flanges, being at their maximum in the middle of the span, and at their minimum near the points of support, yet it is more economical to make the flange angle sections uniform throughout the length of the span, rather than vary the sections, which would involve the necessity of splicing; if the flange stresses cannot be resisted safely by the areas of the largest angle irons manufactured, then it becomes necessary to re-inforce the angles by cover plates of rolled sheet iron, laid on top of the angles and rivetted to them, and this arrangement will then admit of adjusting the total flange areas in such manner as to satisfy the varying stresses in the different parts of the flanges, by gradually increasing the number of the cover plates, or their thickness, from end to middle of girder. These cover plates should always project slightly beyond the outer edges of the horizontal legs of the angles, and they should be rivetted to the angle irons with rivets of such diameter and pitch as the stresses in the different parts of the flanges require. Angle irons are now rolled of such lengths as to make splices entirely unnecessary even in girders of 75 feet length, which is about the economical limit of plate girder bridges; whatever additional price may be asked for angles of such lengths will be fully compensated by the saving in splices.

The upper and lower flanges, composed of angle irons as above described, are connected by a single web plate of rolled sheet iron, which is inserted between the two angles of each flange and rivetted thereto by lines of horizontal rivets of such sizes and pitch as will be necessary to resist the varying shearing strains in the different parts of the flanges; the edges of the web sheets should be flush, or very nearly so, with the upper and lower surfaces of the horizontal legs of the angles. The widths of the web sheets vary of course, with the depths of the girders, which in turn, depend upon the lengths of the spans. Sheets of moderate width, say from 12 to 18 inches, can be had at regular prices, in lengths sufficient to reach from end to end of girders, in spans corresponding to the depths named. As the width of the web sheets increases, the lengths in which they can be rolled diminish, but sheets of 72 inches width can be had in lengths of 20 feet at a cost not exceeding 10 per cent. over the current prices of ordinary sizes; of course, whenever the length of the girders exceeds the lengths of the largest web sheets manufactured, splicing must be resorted to, under the rules which will be explained hereafter. It is the duty of the web sheet to maintain a rigid connection between the upper and lower flanges of the girder, and to equalize the varying vertical shearing strains in the different parts of its length; it is the duty of the flanges to resist the bending moments of the external forces. The sectional areas of the flanges, in connection with the height of the girder, are therefore the elements for determining its resisting capacity.

Although the general design of plate girders does not admit of any great range of variation, still the details depend more or less upon special conditions, and must necessarily be modified by circumstances. Generally speaking, in railroad practice, whenever the clearance height above stream or roadway permits, a so-called deck bridge, with track floor on top of upper flange, is preferred on account of the practicability of closer spacing together of the girders and consequent reduction in floor and lateral brace system If the clearance height is limited, it becomes necessary to to place the floor *between* the girders, either upon the lower flange or at some point between top and bottom flange; this necessitates the widening of the space between girders for the passage of trains, and consequently increases the cost of the floor and lateral connections. In cases where the clearance height is very limited, the iron track stringers are generaly framed between the iron cross floor beams, at such height as to bring the top of the oak cross-ties about one inch above the top of the cross floor beam, in order that the base of the rail may just clear and not touch it. In cases where the clearance height is more ample, the iron track stringers are made to rest upon the top of the cross beams, which should in all cases be attached to the web sheets and flanges of the main girders, by strong gusset plates. The general arrangement of the floor system of plate girder railway bridges is illustrated on page 35.

The girders of single track deck bridges are generally spaced 6 feet 6 inches between centers, and double track deck bridges, when composed of three girders, are so spaced that the centers of the two extreme girders are 9 feet 3 inches from the center of the middle girder. By this arrangement of spacing, each of the three double track deck girders will carry one-third of the combined rolling load on both tracks.

Single track through bridges must be spaced at least 15 feet between centers, and double track through bridges are generally composed of three girders, the centers of the two extremes being 15 feet from the center of the middle girder; when so spaced the outer girders of double track through spans carry one half the live load on one track, and the middle girder carries the entire live load of one track. When the height of the track above the stream will admit of the economical use of heavier floor beams, double track through bridges may consist of two girders, spaced 28 feet between centers, each girder carrying in that case the entire live load on one track.

The floors of single track deck spans generally consist of sawed white oak cross-ties of the usual length of 8 feet 6 inches, 7 inches thick and 8 inches wide, spaced 16½ inches between centers, notched on the girder flanges ¾ inch and secured through the pine guard strips to the girder flanges by hooked bolts, as shown on the sketch. The floors of double track deck bridges consist of sawed white oak cross-ties 20 feet 6 inches long, 9 inches thick, and 8 inches wide, spaced and fastened as shown on the sketch. Pine guard strips 6 by 8 inches are laid outside of, and parallel to, the rails to prevent the upsetting of derailed cars; these guard strips are spliced and fastened in the manner shown on the sketch.

Sometimes oak floor beams are used in through bridges laid directly upon the bottom flanges of the main girders and of sufficient depth and close spacing for the immediate support of the load, the rails being spiked directly to the floor beams and guard strips, and fastenings are used in the same manner as above described. But these floors are objectionable on account of the tendency of oak timber to warp and kink, some of the beams bulging upwards, others bending downwards, some curving horizontally in one direction and some in another, in spite of all precautionary appliances to prevent it. These floor beams require a depth of not less than 14 or 15 inches, and in cases of derailment they are liable to be pushed over and upset on account of their great height in proportion to their narrow base. Iron floor beams and iron track stringers are much to be preferred for all through bridges, for reason of their greater strength and durability, as well as on account of the great lateral stiffness which they impart to the lower parts of the main girders. When iron floors are used, the track stringers, whether framed between the floor beams or resting upon them, are usually spaced 6 feet to 6 inches between centers, and the cross-ties and guard strips are disposed as in single track plate girder deck spans. When the track stringers rest on top of floor beams, they should be well riveted and braced thereto, and strongly spliced at the joints and continued over the piers, and the ends resting on masonry should have bearing plates riveted to them, free to contract or expand in one direction; on skew bridges the stringers should be continued so as to end on a line square to the axis of the bridge.

Stringers framed between the cross beams should be supported by angles riveted to the beams, and the stringer ends should be riveted by means of angle irons to the webs of the floor beams. If track stringers consist of solid rolled I beams, they should be attached to floor beams in the same manner as above provided.

The bearings of all plate girder bridges should be so designed that the weight is transmitted uniformly to the masonry plate. For appearance sake the shore ends of all through bridges should be finished by curving the top chord angles and plates, and continuing them down to the lower chords, using gusset plates for the ends of the floor beams; the ends of plate girders on piers need not be so curved, but they should be separated not less than 6 inches on straight lines, and on curves the ends of outer girders should be separated not less than 8 inches. The radius of finishing curve, measuring to centres of rivets in web, should be 18 inches up to 50 foot span; 21 inches up to 60 foot span; and 24 inches for greater spans. The ends of all plate girders should be closed by plates and angles.

The calculation of the stresses produced in plate girder bridges, and the consequent determination of their necessary dimensions, is exceedingly simple. For uniform static loads, as for instance, the weight of a house front upon a plate girder door cap or lintel, the ordinary formula

$$S = \frac{W l}{8 d}$$ may be used, in which

W = the combined load and weight of beam; l = length of girder between supports in feet, d = distance between centers of gravity of upper and lower flanges in feet, S = the total stress in each flange. Dividing the stress so ascertained by the conventional safety allowances per square inch in compression and in tension, gives the required areas for the top and bottom flanges.

For variable live loads, such as railway trains, the actual bending moments produced by the loads in their most effective positions would have to be ascertained for different parts of the girder at such distances apart as the desired degree of accuracy may dictate, and from these moments, and the additional moments of the dead load of the structure, the flange strains and required sections will be readily found.

Of course the same results can be obtained by other methods, such as Ritter's theory of statical moments, by which the stresses are determined from the differences between the re-actions at the points of support, and the applied loads multiplied by their respective leverage distances; or, the solutions may be reached through the ingenious and elegant method of graphical statics by scale, T square and triangle alone, according to the individual taste and fancy of the engineer.

The web sheet sections must be provided against the vertical shear of the loads applied at the different parts of the girders; this shear is always greatest at the abutments, where it equals the re-action of the total load and weight transmitted to that point, to which should be added, in deck bridges, the accidental wheel loads resting upon the ends of the bridge, in case they produce any effect in excess of the general shear due to the distributed load on the structure.

It is customary, in railway practice, to add to the actual moments of the live loads certain conventional allowances for impact and vibrations produced by rapidly passing loads. These allowances vary with the individual views of the engineers. The effect of these impacts and vibrations upon structures decreases as the length of the span increases. My own practice has been to add 20 per cent. to the maximum bending moment produced by live load on bridges of 30 feet span and less; 15 per cent. on bridges between 30 and 50 feet spans, and 10 per cent. on bridges between 50 and 75 feet spans.

The continuous webs of plate girders expose large vertical areas to the action of the wind, which must be provided for in the lateral brace system.

It is considered safe to allow for the resistance to a wind pressure of 30 pounds per square foot on one and a half times the exposed surface of the girder, to which, should, however, be added the wind surface of the floor. For the wind surface of trains, 300 pounds per lineal foot of bridge is the usual allowance made in the lateral brace system. When plate girders are used in connection with high viaducts, the effect of strong winds acting through the plate girders upon the columns of the viaducts, and upon their supports and anchorage, constitutes a very important element which must be carefully considered in the calculations.

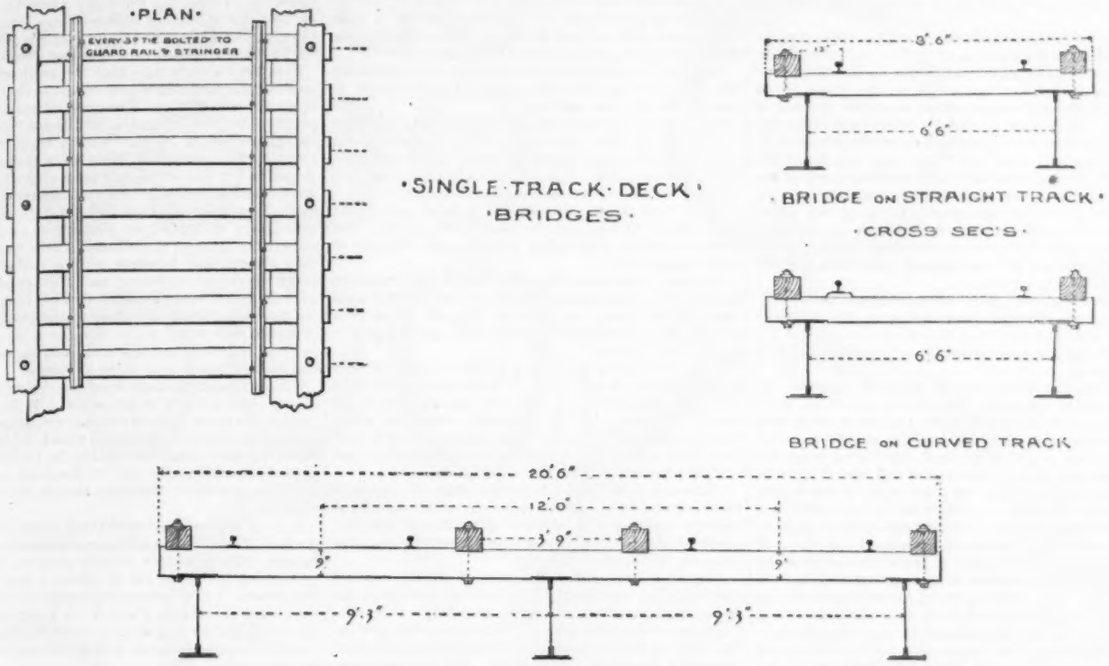
For compressive strain in the top flanges of all riveted girders, including floor beams and track stringers, 8,000 pounds per square inch of sectional area may be allowed, and for tensile strain in the bottom flanges of all riveted girders, 9,000 pounds per square inch; but in computing the required section of the bottom flanges, only the net area, exclusive of the rivet holes, should be taken into account.

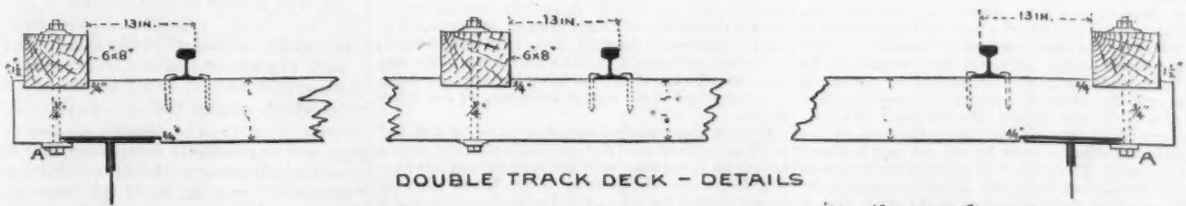
A shearing strain of 7,500 pounds per square inch can be allowed for rivets, and 12,000 pounds per square inch on the bearing surface (diameter of rivet by thickness of plate;) whichever allowance gives the best result for safety should be adopted.

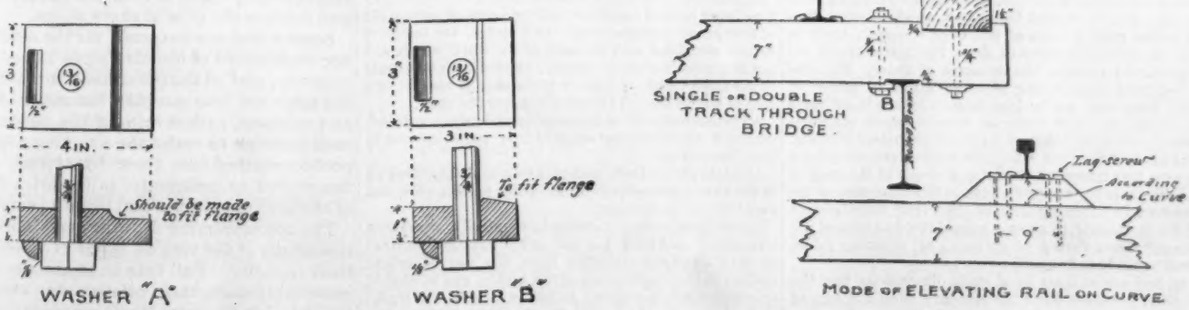
The shearing strain on web sheets across the fibre, should not exceed 5,000 pounds per square inch, and in the direction of the fibre the shearing strain should be limited to 4,000 pounds per square inch.

The tensile strain exerted by the combined forces above mentioned, upon the members of the lateral system, should not exceed 15,000 pounds per square inch of section, and compression in the struts should be lim-

PLATE GIRDER BRIDGES.—DETAILS.







ited to the result of the following formula, in which: S = allowable strain; L = length in inches; R = radius of gyration in inches:

For two square ends:

$$\frac{S = 7{,}500}{1 + \frac{L^2}{36{,}000\ R^2}}$$

For one square and one riveted or pin end:

$$\frac{S = 7{,}500}{1 + \frac{L^2}{24{,}000\ R^2}}$$

For two riveted or pin ends:

$$\frac{S = 7{,}500}{1 + \frac{L^2}{18{,}000\ R^2}}$$

Short struts, whose length does not exceed twenty diameters, may be strained to a maximum of 8,000 pounds per square inch. The web sheets should not be counted as part of the sectional areas of the flanges required to resist the strains.

In case the depth of the girder exceeds the width of the widest plate made, the sheets may be placed with their fibres vertical, but in that case their thickness should be increased not less than 20 per cent., and the spacing of the rivets arranged so as to correspond with the increased thickness of the plates.

In cases where splicing of the web sheets or cover

plates becomes necessary, the splices of the different parts of the girder must alternate, and the splices in one girder must also alternate with those in the other girder of the structure, so that no two splices in corresponding members shall occur directly opposite each other.

All splices in the web sheets should be made double, and their net sectional area, after deducting rivet holes, must be at least equal to double the sectional area of the web sheet spliced; the width of the splice plates must be sufficient to admit of the requisite number of rivets to resist the shear and to correspond with the sectional area of the spliced web sheet; the rivets to be spaced from each other not more than ten times the thickness of the spliced plate, and the distance from the edge of the plate to the nearest rivets must be not less than five times the thickness of the spliced plate. Splices in the cover plates must conform in sectional areas and widths to the provisions above described for splicing of the web sheets, making allowance for the single shear of the rivets.

Web sheets should be of such thickness as to resist the maximum shear of the sections in the different parts of the girders within the safe limits allowed for that strain, but no sheet should be of less thickness than $\frac{1}{4}$ of an inch.

Whenever the unsupported distance between the vertical legs of the angle irons of the upper and lower flanges exceeds sixty times the thickness of the web sheet, vertical stiffeners of angle iron should be introduced on each side of the girders, shouldered under the horizontal legs of the flange angles and spaced apart in distances equal, as nearly as practicable, to the height of the girder through the middle half of its length, and gradually diminishing to one-half the distance apart in the end quarters. Vertical stiffeners must be placed at all web splices. Additional vertical stiffeners must be placed at the end supports of the girders, and in deck bridges these end stiffeners must be sufficiently strong to carry a pair of engine drivers with their impact, in addition to the maximum shear at the abutment supports. At all vertical stiffeners, filler plates, of the same width as the stiffener and thickness of the legs of the flange angles, must be placed between the stiffener and the web plates, and the whole securely riveted together with rivets passing through the entire group. The ends of the fillers must be fitted closely against the edges of the flange angles.

Through bridges must be provided with a full system of horizontal lateral bracing in each panel, using the floor beams for struts, whenever such arrangement is practicable, but providing in that case for the necessary additional flange section to resist the wind pressure, initial strain for adjustment, and centrifugal force on curves.

Deck bridges must be provided with complete top and bottom horizontal lateral bracing, and with diagonal sway bracing, all of ample strength to resist the forces above mentioned.

The compression flanges of beams and girders must be stayed against transverse crippling when their length is more than thirty times their width.

Rivet work must be done with great care, and in the most substantial manner. Rivet holes must be accurately punched and truly spaced, so that when the various parts are assembled, a rivet $\frac{1}{16}$ of an inch less in diameter than the rivet holes can be entered hot without the use of drifts. All rivets must completely fill the holes, and, when possible, should be riveted by machinery. The heads of rivets must be hemi-spherical and of uniform size, for the different kinds of rivets. All rivets found loose or with heads knocked off the centre of the shank, should be cut out and replaced with new ones. The pitch of rivets must never exceed 6 inches, nor sixteen times the thinnest outside plate, nor be less than three diameters of the rivet, except where plates more than 12 inches wide are used in the flanges of beams or girders, or when more than 3 inches of plate project beyond the angles, when an extra line of rivets, with a pitch of not over 9 inches, shall be driven along the edges to draw the plates firmly together, and prevent the entrance of water. The distance from edge of any plate or flange to center of rivet hole shall not be less than 1¼ inches in all cases where the width of plates or flanges admit it; when practicable, it should be at least two diameters of rivets. The pitch of rivets in compressive members should not be over four times the diameter of rivets at the ends of the members for a length equal to two diameters of the member. In punching plate or other iron, the diameter of the die should, in no case exceed the diameter of the punch bymore than $\frac{1}{16}$ of an inch. All abutting joints must be made to fit neatly.

All bed plates must be of such dimensions that the greatest pressure upon the masonry shall not exceed 250 pounds per square inch.

All bridges over 50 feet span should have at one end, nests of turned friction rollers, formed of wrought-iron, running between planed surfaces. The rollers should not be less than 2 inches diameter, and should be so proportioned that the pressure per lineal inch of roller will not exceed the product of the square root of the diameter of the rollers in inches multiplied by 500 pounds.

Bridges less than 50 feet span may be secured at one end to the masonry, and the other end left free to move by sliding upon planed surfaces.

All bridges should be given a camber by making the panel lengths of the top chord longer than those of the bottom chord, in the proportion of ½ of inch to every ten feet.

All rods with screw ends should be upset so that the diameter at the bottom of the thread will be $\frac{1}{16}$ of an inch larger than the body of the bar. The screw threads should be cut according to the U. S. standard.

Diagonal tie rods should be supplied with adjustable sleeves, and clamped at the points of intersection, to prevent sagging and rattling.

All wrought-iron must be tough, fibrous, uniform in quality throughout, free from flaws, blisters, cinder spots, injurious seams and imperfect edges, and must have a workmanlike finish. It must have a limit of elasticity of not less than 26,000 pounds per square inch.

All bar, pin, shape and plate iron (except web plates wider than 36 inches) must be double refined iron. All plates of greater width than 36 inches may be made of extra refined iron.

All iron (except plates of a greater width than 12 inches) should, when tested in specimens of not less than one-half inch sectional area, have an ultimate strength of at least 50,000 pounds per square inch and elongate 15 per cent in 8 inches.

All iron for plates more than 12 inches, and less than 36 inches wide, should have an ultimate strength of at least 48,000 pounds per square inch, and elongate 12 per cent. in 8 inches. All iron for plates of greater width than 36 inches should have an ultimate strength of at least 46,000 pounds per square inch, and elongate 10 per cent. in 8 inches.

All tension iron, if cut into testing strip 1½ inches in width, should be capable of resisting, without signs of fracture, bending cold by blows of a hammer, through about 180 degrees to a curve whose diameter is not over twice the thickness of the piece.

Specimens from angle plate and shape iron should stand bending cold through 90 degrees to a curve, the inner diameter of which is not more than twice the thickness of the piece tested. The hammering must be done only on the extremities of the specimen, and never where the flexure is taking place. The bending must stop when the first crack appears. When nicked or bent, the fracture must be fibrous.

All plates, angles, etc., which are to be bent in the manufacture, must, in addition to the above requirements, be capable of bending sharply to a right angle, at a working heat, without showing any signs of fracture.

All rivet iron must be tough and soft, and pieces of the full diameter of the rivet must be capable of bending until the sides are in close contact, without showing fracture on the convex side of the curve.

A skilled inspector should always be employed by the party for whom the bridge is being built, who should examine and test the iron before it is worked in the shop, and should have constant supervision over the work during its progress, with full power to reject all materials or workmanship not in conformity with the specifications or drawings.

The contractor should be required to furnish him, without charge, such test pieces as the inspector may designate, and ship them to such point for testing as the inspector may direct. In addition thereto, the inspector should have the right to select, at any time during the progress of the work, any of the manufactured members, and submit them to such tests as he may deem proper; and if they fall below the required standard he may reject all similar members, or the entire bridge.

All such manufactured members taken for test, and which prove to be good and acceptable material, should be paid for at the net cost of the material and labor expended thereon, less its scrap value; but no payment should be made for any material or workmanship which prove to be defective.

All surfaces coming in contact should be painted, before being riveted together, with one coat of pure oxide of iron paint and linseed oil. Bed plates, the inside of closed members, and all parts of the work which will not be accessible after erection, should have two coats of the same paint. All other parts should receive one coat of boiled linseed oil before leaving the shop.

All bridges should be thoroughly and evenly painted, with two coats of pure oxide of iron paint, ground in pure linseed oil.

All plate girder bridges should be completely fitted up in the shop before shipment to insure perfect work and avoid delays in erection.

The contractor should always be required to guarantee immunity, and hold his customers harmless against suits or damages resulting from the use of patent devices in the construction of the bridge, and he should so conduct his operations as not to impede the traffic of the railroad or highway. He should be held responsible, and assume all responsibility for any failure of the bridge during erection, and for any accident that may occur to trains, or to any passenger or employe, resulting from carelessness or neglect of the contractor or his workmen.

The contractor should agree to comply with all laws, ordinances, or other regulations of the proper authorities, which might in any way affect the work under this contract, and should consider himself responsible for any damages arising from a neglect or disregard of said laws, ordinances and regulations.

These are the principal and essential provisions which practice and experience have led me to embody in the agreements with builders engaged in the construction of plate girder bridges on the lines of railway under my charge; but while my remarks apply more particularly to Railway Bridges, there is no reason why the adoption of plate girders for highway bridges should not be found equally practicable and economical.

They are far more rigid than the ordinary trussed or arched highway bridges now in use, so that the trotting of horses or a possible stampede of cattle, would not produce the objectionable vibrations, which are not always prevented by sign-boards prohibiting under penalties the passage of teams at a faster movement than a walk. The erection of plate girders under equal circumstances is always less troublesome than that of framed structures. Plate girder through bridges would form of themselves perfect side projections and answer the purpose of railings. Their maintenance is very simple, and requires only a periodical coat of paint to prevent corrosion, and, least of all, the fiend with the screw wrench would find his occupation gone for there would be no counters to tighten, and the lives of the tie rods would not be destroyed any longer by twisting the screw threads until their elasticity is gone, and the first shock tears them to pieces.

I had intended to allude briefly to the relative merits of steel plate girders as compared with iron ones, but even if this paper had not already trespassed too much upon your time and patience, I would be compelled to desist, for the simple reason that the properties of steel are not yet sufficiently well understood to rely upon them in cases where absolute safety is the first consideration.

As long as such acknowledged authorities as C. L. Strobel, of the Keystone Bridge Company, and Charles Bender, differ so widely on this question, it would be very presumptious in me to advance any opinion on the subject. I will therefore be content in the continued use of iron structures of which we know what they are able to do, and as long as they prove satisfactory, I will always be willing to speak well of the bridge that carries me safely over.

Standard Forms of Sewers Adopted for the City of Washington.

The following matter is extracted from the late report of Capt. F. V. Greene, U. S. Engineers, to Major Lydecker, the Engineer Commissioner of Washington, D. C.:

The form of sewer adopted as a standard and shown in the accompanying illustration is from the design of Capt. R. L. Hoxie, U. S. Engineer's, who during four years service as Engineer of the district andsixyears as Engineer Commissioner had devoted careful and elaborate study to this subject.

The general principles of the adopted system of sewerage in Washington are as follows:

1st. The system is entirely what is known as the "combined" system—*i. e.*, the sewage and rainfall are carried off in the same channel.

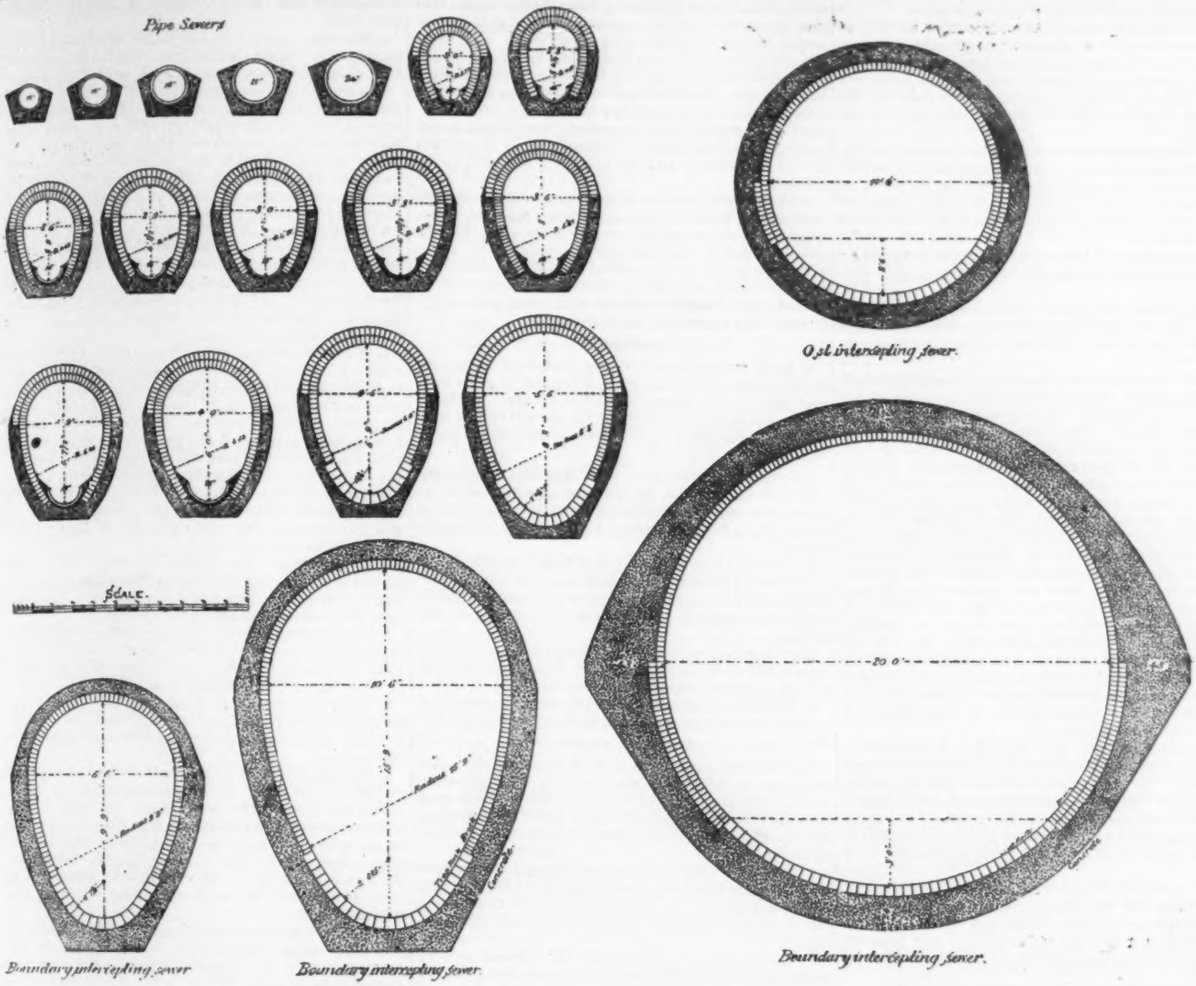
2nd. The adopted form of brick sewer is oval, the invert or bottom being of glazed, vitrified pipe which carries the dry weather flow or sewage proper. The smooth surface of this pipe and its relatively small area give all the practical advantages which are claimed for the "separate" system, while the large area of the rest of the sewer gives ample room for the storm water, which in turn thoroughly flushes and purifies the pipe at every storm.

Sewers that are too small for the oval shape are constructed of circular pipes imbedded in concrete, and on the other hand those that are too large are also circular, but made of brick and concrete, with inverts of the hardest trap rock in order to resist the grinding action of pebbles washed into them by storms, which has proved so destructive to the brick inverts of the sewers built ten and twenty years ago.

The accompanying drawings and table show the details of the various types of sewers and their capacity. Full data as to the amount of material in each, their relative cost, etc., were published in Captain Hoxie's report for last year.

3rd. The size of sewer for a given locality is computed by Kutter's well known formulæ on the basis of a rainfall of 2 inches per hour, all of which is to be carried off by the sewer within the hour. This is very much in excess of the computations which have been usually adopted in other cities, where the maximum rainfall has generally been taken at one inch

STANDARD FORM OF SEWERS---WASHINGTON, D. C.



per hour, and one-half of this has been estimated to reach the sewer and the other half to be absorbed by the ground and evaporation; but experience has shown that with our smooth pavements and sudden heavy showers the above data are not too large. The New York sewer, constructed in 1881 on this basis, has run full in heavy storms.

$$v = \frac{41.66 + \frac{.002807}{S} + \frac{1.8113}{n}}{\left(41.66 + \frac{.002807}{S}\right)\frac{n}{\sqrt{R}} + 1}\sqrt{R\,S},$$

in which

v = velocity in feet per second.
R = hydraulic radius.
S = slope.
n = constant of roughness.
Adopted value = 0.13.

These three principles—the "combined" system, oval shape and 5-inch rainfall—are the basis of the sewerage system as now being carried to completion.

DIMENSIONS AND CAPACITY OF THE STANDARD SEWERS OF WASHINGTON, D. C.

Dimensions in feet.	Area in sq. feet.	Relative capacity	Relative cost	Discharge in cubic feet per second with slopes of			Area drained in acres, 2 inches of rainfall per hour.		
				1/100	1/400	1/900	1/100	1/400	1/900
1 00	0 78	1 00	1 00	3 39	2 40	1 96	1 68	1 19	0 97
1 25	1 23	1 84	1 09	6 25	4 42	3 61	3 09	2 19	1 78
1 50	1 77	3 05	1 28	10 35	7 32	5 97	5 13	3 63	2 96
1 75	2 40	4 65	1 60	15 78	11 16	9 10	7 83	5 53	4 52
2 00	3 14	6 68	2 07	22 68	16 04	13 08	11 25	7 95	6 49
2 00 × 3 0	4 64	10 81	2 80	36 69	25 94	21 17	18 19	12 86	10 49
2 25 × 3 37	5 92	15 17	3 06	51 50	36 41	29 71	25 53	18 05	14 23
2 50 × 3 75	7 23	19 40	3 32	65 85	46 56	39 99	32 65	23 08	18 84
2 75 × 4 12	8 71	25 51	3 58	86 60	61 23	49 97	42 94	30 36	24 78
3 00 × 4 50	10 41	32 46	3 85	109 84	77 66	63 38	54 49	38 50	31 43
3 25 × 4 87	12 13	40 15	4 12	136 29	96 36	78 64	67 58	47 78	38 99
3 50 × 5 25	14 10	49 26	4 39	167 33	118 30	96 55	82 97	58 66	47 87
3 75 × 5 62	16 19	59 30	4 66	201 36	142 29	116 13	100 00	70 56	57 70
4 0 × 6 0	18 54	70 69	4 94	239 97	169 66	138 46	118 99	84 13	68 66
4 25 × 6 37	20 70	82 10	5 34	278 72	197 06	160 82	138 23	97 73	79 76
4 50 × 6 75	23 26	95 75	5 75	325 05	229 81	187 55	161 18	113 95	93 00
4 75 × 7 12	25 91	110 82	6 25	376 20	265 97	217 07	186 55	131 89	107 94
5 0 × 7 50	28 71	126 44	6 78	429 22	303 46	247 66	212 84	150 48	122 81
5 25 × 7 87	31 67	144 84	7 25	491 67	347 61	283 69	243 81	172 37	140 68
5 50 × 8 25	34 74	163 13	7 80	553 78	391 52	319 53	274 61	194 14	158 45
5 75 × 8 62	37 95	184 51	8 35	626 19	442 72	361 31	310 51	219 53	179 16
6 0 × 9 0	41 61	205 89	8 90	698 91	494 13	403 27	346 58	245 02	199 97
6 5 × 9 75	48 53	254 60	10 10	864 21	611 00	498 65	428 54	302 98	247 27
7 0 × 10 50	56 27	309 25	11 30	1,049 79	742 20	605 73	520 57	368 04	300 37
8 0 × 12 0	73 52	440 00	13 90	1,493 95	1,056 26	862 00	740 82	523 76	427 45
9 0 × 13 50	93 06	597 80	16 20	2,029 28	1,434 70	1,170 89	1,006 28	711 42	580 62
10 5 × 15 75	126 66	899 00	18 75	3,050 94	2,157 02	1,760 39	1,512 91	1,069 63	872 95
10' circular	78 54	493 63	13 52	1,673 66	1,183 28	965 70	829 94	586 77	478 86
20' "	314 16	3,016 73	58 77	10,240 64	7,240 13	5,908 85	4,078 10	3,560 22	2,930 06

Specifications for Sewer Work, Washington, D. C.

The right is reserved to the Commissioners, D. C. to modify the foregoing schedule and tables as to quantity of work or location, either before the award of contracts or at any time thereafter.

The depths of excavation given in the foregoing schedule are intended for maximum depths, but circumstances may cause a variation, either to increase or diminish them. The contractor is required to give a price per cubic yard for excavation and refilling, which price will be allowed in addition to the contract price in case of increase, or deducted in case of a reduction of the specified depth.

TRENCHES.

1. The ground shall be excavated in open trenches to the necessary width and depth, that portion formed for the invert of the sewer to be excavated to the exact form and dimensions of the same, should the nature of the ground so allow. If the soil be of improper nature for a foundation, it shall be removed to such depth and width and in such manner as the Engineer Commissioner may direct, and other material deposited in its place, which will be paid for as extra work.

2. All irregularities, however, otherwise caused in the bottom and sides of the trench below the center of the sewer shall be filled to the required form with hydraulic cement concrete, made as herein specified, at the expense of the contractor.

3. Bracing and shoring shall be used when the same may be necessary to prevent slipping or caving of the sides of the trench, but no allowance will be made therefor; in all cases the timber and planking are to be removed in such manner as to prevent the slipping or caving of the sides as the work progresses, unless otherwise ordered by the Engineer Commissioner. If ordered to be left in the trench, the bracing and shoring so left will be measured and paid for at the rate of fifteen ($15,00) dollars per 1 M feet board measure.

4. On the 10.5 × 15.75 and 20 feet sections of the northeast Boundary sewer the measurement of excavation will allow a cross-section giving a slope of 1½ perpendicular to 1 base from the springing line of the arch to the natural surface, and below the springing line only the external form of the invert. On the 6.5 × 9.75 section, side slopes will be allowed of 10 perpendicular to ½ base, and the external form of this invert. Shoring will not be paid for, but, if used, the same cross-sections will be allowed.

5. Should running sand, quicksand, or other treacherous ground be encountered, the work shall be pushed

with the utmost vigor, and be carried on day and night, should the Engineer Commissioner so require.

6. The excavations shall be kept free from water during the construction of the work; no concrete or other work will be allowed to be laid in water, and no allowance for pumping or otherwise removing the water will be paid, and all slides or caving of the sides of the trenches or cuts will be removed at the cost of the contractor.

7. The backfilling over and about the sewers shall be done with especial care. It must be brought up evenly on both sides of the sewer to the top of the arch, in layers not exceeding four (4) inches in depth and thoroughly rammed, the operation requiring three rammers to one shoveler.

The contractor will be responsible for all after settlement over the line of the trench, as hereinafter provided.

8. The surface of the street or sidewalk shall be left in as good condition as before the commencement of the work, the proper material being reserved for this purpose.

9. The contractor will replace all pavements disturbed, excepting asphalt or concrete pavements, which will be relaid by the District. If, however, such pavements should be injured by the contractors outside the limits prescribed for the trenches, the cost of restoring such excess will be charged against the contractor and deducted from any amounts found due, and he will be required at his own expense to maintain the ground surface of the pavement over the line of trench with the best material available from the excavation, until such time as the pavement is relaid. The cost of subsequent repairs of all pavements (whether relaid in the first instance by the District or by the contractor) or of any other work, made necessary within the period for which this work is guaranteed, by after settlement in the filling of the trenches, will be charged against the ten per centum retained and invested, as provided in paragraph seven of the general conditions hereto attached, and it is expressly agreed that this fund shall be subject to the control of the Commisioners of the District of Columbia for this purpose.

10. The material from the trenches and that used in the construction of the work shall be so deposited as not to endanger the work or unnecessarily obstruct public travel, and so that free access may be had at all times to all fire plugs and water gates in the vicinity of the work. The surplus earth as hereinafter indicated will be the property of the contractor and must be disposed of by him.

On the northeast Boundary sewer the surplus earth hauled away will be measured at 90 per cent. of the actual displacement of the sewer, and will be hauled to such places along the line of the work as may be directed by the Engineer Commissioner. Average haul about 3,000 feet.

For removing the surplus earth on this sewer a separate price will be paid; but on all other sewers this item will be included in the price per foot for the sewer.

SEWER.

1. The sections of the various sewers are to be made in strict conformity with the drawings furnished by the Engineer Commissioner, and the line and levels given by the duly authorized assistant, and the directions given from time to time by the Engineer Commissioner or his agents. The work is subject to such modifications as may be necessary during its progress; and in no case will any work in excess of the plans and specifications be paid for unless ordered in writing by the Engineer Commissioner. Water-tight work is required, and, to secure this, none but the best quality of material of the several descriptions shall be used. All work shall be done by skilled workmen in the various departments of the same. Proper moulds, centres and forms will be furnished and kept in good condition by the contractor.

2. All railroads, water, sewer, and gas pipes across or near the work shall be supported during the construction of the work under or near them, so as not to interfere with or delay the use of said railroads or the flow of water, gas, or sewerage; all at the expense of the contractor.

The existing sewers in Boundary and other streets shown on the drawings in the office of the Engineer Commissioner must be protected and secured against damage by and at the expense of the contractor.

3. The connections of intercepted sewers and catch-basin connections with the new sewers will be made according to the plans and directions given by the Engineer Commissioner and the cost of said connections included in the price per foot for new sewers. The connections with new basins will be paid for at a separate price. The connections with sewers will generally be made with curves having a radius of not less than thirty feet. Drops for the dry weather flow are to be built in the Boundary and O street sewers, not exceeding three. These will conform to the drawings on file in the office of the Engineer Commissioner, and the cost of the same will be included in the price paid for those sewers.

BRICK-WORK.

1. The best quality of whole new bricks, burned hard entirely through, free from injurious cracks, with true even faces, and with a crushing strength of not less than 5,000 lbs. per square inch, will be used, and must be thoroughly wet by immersion immediately before laying. Every brick is required to be laid in full mortar joints, on bottom sides and ends, which for each brick is to be performed by one operation. In no case is the joint to be made by working in mortar after the brick has been laid. Every second course will be laid with a line, and joints will not exceed ⅝ of an inch. The brick-work of the arches shall be properly bonded and keyed as directed by the Engineer Commissioner. No portion of the brick-work will be laid dry and afterwards grouted.

2. Terra cotta junction blocks will be built into the arch of the brick sewers, and Y branches laid in the pipe sewers at such places as are shown on the plan or are indicated by the Engineer Commissioner. These will be furnished the contractor free of cost, and are to be built into the sewers, and the ends projecting from the concrete foundation closed with brick and cement by and at the expense of the contractor.

MANHOLES.

1. Brick manholes will be constructed in the sewers at intervals of 150 to 200 feet. They are to be of form and dimensions shown on the drawings. Manholes in sewers over 5 feet in vertical height will spring from one side of the sewer; in smaller sewers from the top of the arch.

Manholes are to be fitted with cast-iron frames and covers in dimensions, weight, and quality similar to those now used in Washington, and the drawings of which are on file in the office of the Engineer Commissioner.

2. The iron is to be sound, free from imperfections, and thoroughly cleaned. Each manhole will be furnished with wrought-iron steps built into the brick-work, conveniently arranged to allow access to the sewer.

The manhole covers on the Boundary and O street sewers will be of the large pattern, 3 feet diameter; all others, the small pattern ordinarily used.

3. Lateral sewer and receiving-basin connections will be built into the manholes whenever required.

RECEIVING BASINS.

1. Receiving basins will be built wherever shown on the plans or ordered by the Engineer Commissioner. They will conform to the drawings, will be built with care, and be made perfectly water-tight by plastering the interior with neat hydraulic cement ½ inch in thickness.

2. The tops of the basins will be covered with granite or blue-stone heads set level with the sidewalk; the stones composing the tops will be rebated to receive a cast-iron cover similar to those now in use in Washington.

3. Connections of basins with the sewers will be made with 12-inch or 15-inch pipes of terra cotta, laid in cement concrete, as required for the sewer pipes.

MORTAR.

1. Mortar, wherever used in this work, will be composed of cement and dry sand, in the proportion of 300 pounds of cement and two (2) barrels of loose sand *thoroughly mixed* dry, and a sufficient quantity of water afterwards added to form a rather stiff paste; it will be used within an hour after mixing, and not at all if once set.

2. Cement shall be of the best quality, freshly burned, and equal in every respect to the Round Top or Shepardstown cement, manufactured upon the formula of this office, capable of being worked for twenty minutes in mortar without loss of strength, and will be tested in such manner as the Engineer Commissioner may direct. It will have a tensile strength, as follows, when mixed with water and allowed to set for twenty-four hours, then immersed in water until taken out for testing at the expiration of one week thereafter:

Neat cement	95	lbs. per sq. in.
One part cement and one part sand	56	"
" " two "	22	"
" " three "	12	"

3. Sand used shall be clean, sharp, free from loam, vegetable matter, or other dirt, and capable of giving the above results with the cement.

4. Water used shall be fresh and clean, free from earth, dirt, or sewerage.

5. Tight mortar boxes shall be provided by the contractor, and no mortar shall be made, excepting in such boxes.

6. The proportions given are intended to form a mortar in which every particle of sand shall be enveloped by the cement, and this result must be attained to the satisfaction of the Engineer Commissioner and under his direction

7. The through mixing and incorporation of all materials will be insisted upon, preferably by machine labor; but if done by hand labor, the dry cement and sand will be turned over and mixed with shovels by skilled workmen not less than six times before the water is added. After adding the water, the paste will again be turned over and mixed with shovels by skilled workmen not less than three times before it is used.

CONCRETE.

1. Concrete will be composed of mortar proportioned and mixed as before described, to which will be added broken stone in such proportion that the resultant mass will contain for every 300 lbs. of cement two barrels of loose dry sand and five barrels of broken stone or hard brick.

2. The stone or brick will be added immediately after mixing the mortar, being first completely drenched with water, but containing no loose water in the heap.

The whole mass shall be thoroughly turned over and mixed until every particle of broken stone is completely covered with mortar, using only sufficient water to insure the proper incorporation of the ingredients.

If not mixed by machinery, the concrete material will be turned over and mixed with shovels by skilled workmen upon a water-tight platform of sufficient size not less than four times before it is used.

3. Broken stone or brick shall consist of angular fragments of sound durable stone or brick, broken preferably by the crusher or roller, not exceeding 1½ inches in their greatest dimension, and will be thoroughly freed from dust and dirt by screening or winnowing. After the latter operation it will not be deposited or handled except upon clean boards.

4. The proportions given are intended to form a concrete in which the cement mortar shall be sufficient to fill all the void spaces with mortar to excess. If from imperfect mixing or other cause it shall appear to the Engineer Commissioner that such a result is not attained, the proportion of broken stone or brick will be adjusted to his satisfaction without extra compensation. If it should be found that the stone is so proportioned that the mortar is considerable in excess of the amount required to fill the void spaces, the proportion of stone will be increased, but only upon the written order of the Engineer Commissioner.

5. Each batch of concrete will be rapidly mixed and spread in layers not exceeding six inches in thickness, and will be at once thoroughly compacted by ramming until free mortar appears on the surface.

6. The concrete will not be allowed to be passed down to its place in a shute, but must be deposited so as to retain the mortar evenly incorporated with the stone and free from foreign matter of any kind.

7. The whole operation of mixing and laying each batch will be performed as expeditiously as possible, with the use of machinery or of a sufficient number of skilled men.

8. The concrete will be accurately laid to the prescribed section by the use of proper templates or forms, and in case any of the sewer arches are built of concrete instead of brick, the contractor will be required to prepare the centers so that the concrete will not adhere to them, and so that when removed the intrados of the arch will present a perfectly smooth finished surface. If necessary, the intrados will be plastered with cement mortar.

9. Concrete will be allowed to set at least 24 hours before any work or back filling shall be put upon it, and no walking over or working thereon will be allowed during such time.

SEWER PIPE.

1. Sewer pipe will be circular, vitrified stoneware, or terra cotta sewer pipe, of the dimensions specified, and laid in a bed of hydraulic cement concrete, as shown in the sections on file in the office of the Engineer Commissioner.

2. For sewers with half pipe inverts the pipe will be carefully divided longitudinally in halves, and laid in place by being imbedded in mortar composed of one (1) part best quality fresh Portland cement, and one and a half (1½) part clean sharp sand, mixed and used as required for cement mortar. The bed for the pipe will be formed one-half (½) inch in thickness entirely around the pipe, the joints fully flushed, and the cut edge of the pipe covered by the mortar, with the mortar flushed up to the brick-work, as shown in the drawings. The Portland cement must have a tensile strength of 250 pounds per square inch when mixed with water only, and five days after setting.

STONE BLOCKS FOR INVERTS.

1. The invert of sewers larger than 4' × 6' will be laid with stone blocks, as shown in the sections. The blocks will be laid with full joints in Portland cement mortar of the quality and mixed in the manner above specified.

MISCELLANEOUS.

1. The junction of different diameters of new sewers will be made with conical sections sixteen (16) feet or more in length, retaining the slope of the arch of the sewers.

2. The ends of all sewers, except at their discharge, will be securely closed with brick masonry laid in cement mortar, as prescribed for brick-work.

3. On the completion of the sewers, they shall be thoroughly cleaned out before acceptance.

4. The contractor shall furnish the inspectors with proper means and facilities for weighing the cement in barrels and the barrels after being emptied, and for measuring the sand, broken bricks and broken stone.

5. All quantities of work and material to be paid for will be measured and determined by the Engineer Commissioner and his assistants, according to the plans and working lines which may be given, and the specifications.

9. All material furnished and all work done which, in the opinion of the Engineer Commissioner, shall not be in accordance with these specifications, shall be removed within twenty-four hours after written notice

from the Engineer Commissioner by and at the expense of the contractor; or, in case of his failure to do so, it will be removed by the Engineer Commissioner, and the cost will be charged to the contractor and deducted from the amount due or which may become due the contractor.

7. Material to be furnished by the District (consisting of sewer pipe, branches, junction blocks, and stone blocks) will be delivered to the contractor on the wharf or at one of the property yards of the District, and will be hauled to the work by the contractor. It will be considered as a cash payment in addition to the contract rates, and ten per cent. of its value will be retained, as provided by law. See paragraph five of the general conditions hereunto appended.

8. The contractor will be required to refill trenches, remove surplus material or supplies, and restore the streets to their original condition with all possible promptness; also to maintain suitable bridges over trenches at street crossings in such manner as to accommodate travel on foot or by vehicle, all to the satisfaction of the Engineer Commissioner and as he shall direct. All lights necessary for properly lighting the trenches, or other obstructions to travel, must be maintained at the expense and risk of the contractor.

The Signal Service on Mt. Washington.

The Detroit *Evening Journal* contains a letter detailing signal service life on Mt. Washington, and from it we make the following extracts:

The station is of wood, about 25×35 feet in size, containing four rooms. Wooden beams, one foot square, are bolted to the rocks at one end, and, slanting over the house at the same angle as the roof, over which they are joined together, hold the building down in case of wind storms. Three persons—two single men and a man-of-all-work—are at the station continually. Five observations are taken daily, at 7.23 and 11.23 A. M. and 3.23, 7.23 and 11.23 P.M. Those are even hours, Washington time. Three of these observations are telegraphed to Washington. A telegraph cable connects the station with the base of the mountain, at which place, during the summer, a telephone is in operation, the same wire being used. During the past summer six rain gauges have been placed on each side of the mountain at different altitudes, to ascertain the rainfall at various heights. Anemometer cups, record-the velocity of the wind, are also placed at different points. In the winter, the snow and ice render these mountain experiments impossible, and all the instruments are placed close to the station. The temperature averages about 35 degrees in summer, 71 degrees being the highest reached last season. The coldest weather recorded there is 49 degrees below zero. This winter has a record of 42 degrees below, the wind attaining a velocity of 100 miles an hour. In summer there is a great deal of mist, cloudy weather, and rain. Snow falls heavily in winter, but blows into Tuckerman's ravine, leaving the summit generally bare. This ravine, 500 feet deep, is full of snow in winter, and if is never entirely free from drifts. The summers are not long enough to melt it.

The communication with the summit by railroad is, of course, well known. When the trains are not running, there is only left the Glen carriage road, eight miles long, and the mountain path through the ravine, a distance of six miles. The Appalachian Club always go up by the ravine, but it is very fatiguing and quite perilous. As soon as the tourist season closes, the bridges over the carriage road are taken up, and the only way left is to walk up the track, a distance of three miles.

Once in two weeks one of the men goes after the mail, which comes to Fabyan's, the nearest point. As they take turns, each man gets down only once in six weeks. These journeys are quite dangerous and difficult. A day each way is taken for travelling, and a day of rest at Fabyan's. The great velocity of the wind and the sleet, which forms ice on the ties of the railroad, are the disagreeable features. The ties are at such an angle, that in walking down the heel catches in the corners; in walking up they act as steps. The road is constantly crossing gullies, sometimes at a height of 40 feet, with jagged rocks underneath and, perhaps, a chasm 200 feet deep close at the side. A slip and a fall would probably be fatal. The ties get so frosty that walking is extremely difficult, and the fogs are very dense. There are such changes in the weather at different altitudes that when all is pleasant at the house the wind and snow will be simply irresistible a little distance up the mountain."

There is an appliance called a slide board, which is used before the ice and snow cover the track. This board is about three feet long and 18 inches wide, with a seat at one end and a crossbar at the other for the feet. In the middle of the three tracks is a cog about six inches wide, an iron band rising upon each side, about two inches above it. Upon each of these iron bands, resembling a rail, the slide board rests, two grooves of iron furnishing the indentation for the rails. The board thus slides to the base very rapidly. The distance of three miles has been made in a little over three minutes. A lady from Chicago went down last summer in about that time. The only way to stop this machine is by friction, furnished by a brake held in both hands. This brake presses on the under side of the iron boards. It takes great strength in the arms to stop the car, and if one has held on tight enough to reduce the speed to about 30 miles an hour, which is as slow as it is possible to travel, by the time the rider is half way down he has very little strength left. It is practically impossible to stop the slide board after a good start has been obtained. Only those who are very strong in the arms can do it. If the brake should become uncontrollable you can imagine how fast the board would travel toward the base. It excels a railway train in speed, anyway. Last fall a man, riding on a slide board, was thrown off by an accident to the machine and fell 40 feet onto a pile of rocks and only a few feet from a chasm 200 feet deep. He was severely injured, but recovered. Very few people have the nerve to ride on the slide board.

Timber Supply of the World.

From a paper on "Past, Present and Future Sources of the Timber supplies of Great Britain," read by P. L. Simmonds, at a meeting of the Society of Arts, England, we extract the following statements:—

Great Britain, in proportion to its size, is probably the largest consumer of wood in the world, and the demand constantly increasing. From 3,400,000 loads of foreign and colonial wood, of all kinds, received in 1858, the quantity has increased to 6,640,000 loads in 1883; this last import is valued at £17,742,660. In 1854 three-fifths of the wood imported came from the English territory; in 1883 only about one fourth came from her own possessions, in India and the Colonies.

In Europe, Norway and Sweden has more than 177,000,000 acres of woodland, mostly spruce, pine and fir; and it is stated that in fifteen years this supply will be very materially reduced, judging from the present rate of export, which has averaged 900,000 tons per annum for the past ten years.

Russia, with 527,000,000 acres of timber, exports no more than the Scandinavian countries. In an official report on Russian forests, 33 per cent. of the total area of the country is reckoned to be woodland. As compared with this, Austria has 29%; Germany, 26%; France, 19%; Italy, 18%; and Turkey, 14%. The forests of the Crown, in Russia, deliver annually 600,000,000 cubic feet of timber, of which England takes 40%. and Germany, 35%.

Spain and Portugal, with 6,000,000 acres of woodland contribute little to the timber trade of the world; while France, with her 22,000,000 acres, can spare no wood, but needs it all fo home consumption. Germany has 40,000,000 acres of timbered land, takes good care of its forests, and the greatest quantity of the best European wood is produced there. Italy, with 7,000,000 acres, exports a limited quantity of excellent timber.

Turkey and Greece furnish scarcely any timber, and Switzerland and Belgium consume more than they produce. In Austria, with 45,000,000 acres covered with forest, which annually furnish about 17,000,000 cubic cords of wood, the best timber, unfortunately, is in the mountainous districts and is consequently difficult and expensive to remove.

But the future timber supply of the world must come from North America. Canada alone has 1,000,000,000 acres and the United States very nearly as much. The whole timber acreage of Europe amounts to only 800,000,000 acres, much less than half of the American supply. But the author states that the United States can not be depended upon for any continuous supply, as her shipments for some years past have been stationary at a little over £3,000,000 sterling in value.

The forests of Africa are at present little known and inaccessible, and Australia contributes but little, with an increasing local demand; Canada and Northern Europe are alone regarded as reliable sources of a present supply for England according to Mr. Simmonds.

Cements for Special purposes.

The value of a cement is, first, that it should become a strongly cohering medium between the substances joined; and, second, that it should withstand the action of heat, or any solvent action of water or acids. Cement often fails in regard to the last consideration. For waterproof uses several mixtures are recommended, and the following may be mentioned. One is to mix white lead, red lead, and boiled oil, together with good size, to the consistency of putty. Another is powdered resin 1oz., dissolved in 10oz. of strong ammonia; gelatine 5 parts, solution of acid chromate of lime 1 part. Exposing the article to sunlight is useful for some purposes. A waterproof paste cement is said to be made by adding to hot starch paste half its weight of turpentine and a small piece of alum. As a cement lining for cisterns, powdered brick 2, quicklime 2, wood ashes 2, made into a paste, with boiled oil, is recommended. The following are cements for steam and water joints: Ground litharge 10lb., plaster of Paris 4lbs., yellow ochre ½lb., red lead 2lb., hemp, cut into ½ in. lengths, ½ oz., mixed with boiled linseed oil to the consistency of putty. White lead 10 parts, black oxide of manganese 3, litharge 1; mix with boiled linseed oil. A cement for joints to resist great heat is made thus: Asbestos powder, made into a thick paste, with liquid silicate of soda. For coating acid troughs, a mixture of 1 part pitch, 1 part resin, and 1 part plaster of Paris is melted, and is said to be a good cement coating.

Correspondents frequently ask for a good cement for fixing iron bars into stone in lieu of lead, and nothing better is known than a compound of equal parts of sulphur and pitch. A good cement for stoves and ranges is made of fire-clay with a solution of silicate of soda. A glue to resist damp can be prepared with boiled linseed oil and ordinary glue; or by melting 1lb. of glue in two quarts of skimmed milk, shellac 4oz., borax 1oz. boiled in a little water, and concentrated by heat to a paste. A cement to resist white heat may be usefully mentioned here. Pulverised clay, 4 parts; plumbago, 2; ironfilings, free from oxide, 2; peroxide of manganese, 1; borax, ½; seasalt, ½; mix with water to thick paste; use immediately, and heat gradually to a nearly white heat. Many of the cements used which are exposed to great heat fail from the expansion of one or more ingredients in them, and an unequal stress is produced; or the two substances united have unequal rates of expansibility or contractility; the chemical or galvanic action is important. The whole subjects of cements has not received the attention it deserves from practical men. Only Portland cement has received anything like scientific notice, and a few experiments upon waterproof, heat-resisting, and other cements would show which cements are the best to use under certain circumstances.

Engineering News

AND

AMERICAN CONTRACT JOURNAL.

Tribune Building, - - - New York City.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

PUBLISHED EVERY SATURDAY.

CONDUCTED BY

GEO. H. FROST, - - - Assoc. Am. Soc. C. E.
D. McN. STAUFFER, M.Am.Soc.C.E.: M.Inst.C.E.

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The Settlement of the Tower on the Philadelphia Public Buildings.

The citizens of Philadelphia are justly alarmed at the very evident signs of settlement in the masonry of the clock tower which is to eclipse all other work of human hands in height, and forms so important an adjunct to a building which has already cost millions.

From the report of architect McArthur, to the Building Commissioners, we learn that the settlement is confined to the masonry above the foundations; the latter extends 30 feet below the street surface and is composed of bedded Conshohocken limestone laid in cement mortar and rests upon a bed of concrete on a gravel sub-soil. The present damage shows itself in the spalling of the finely cut joints in the granite and sand stone facing walls, and the breaking off of considerable portions of the ornamental stone work by pressures thrown upon them which they never were intended to carry. Three out of four great marble lintels over the main entrance, are also cracked in half by a similar cause.

The hearting of all these walls is brick work, and Mr. McArthur states that by examination, it is shown, that while the mortar is well set in the exterior portions of these walls, it is still partly in an unset condition in the interior. Incidently he mentions that portions of this brick work have actually been tested, under U. S. authority and in the presence of the Commissioners, to an ultimate pressure of 99 tons per square foot, while the greatest weight on any part of the structures does not yet exceed 9 tons per foot.

The architect ascribes the trouble to the "flushing" of the outer joints of some of the delicate members of the ornamental facing, whereas the joints should have been left open to allow for the usual settlement or compression. He is now at work relieving the facing joints by cutting out the mortar. He has no fears for the ultimate security of the walls.

The solution of the present problem is rather important when we consider that the mischief making tower has yet to be raised some 300 feet before it attains the height originally proposed. Without data it is, of course, useless to argue either as to cause or ultimate effect; the architect has a professional name above reproach, and we must therefore await developments and judge from a better standpoint than that furnished by the opinion of an average press reporter upon professional matters.

Brooklyn Bridge Notes.

At the regular meeting of the Brooklyn Bridge Trustees, on Jan. 13, on motion of Mr. Thurber, the car fare on the bridge was reduced from 5 cents to 3 cents, or 40 tickets for $1.00. This order is to take effect March 1st. next. In answer to the objection of one of the Trustees that at times they now had more travel than could be properly provided for, Mayor Grace suggested that if they would furnish the crowding feared, means for providing for this crowd would necessarily be found. A proposition of Mr. Thurber, to reduce the pedestrian toll to 25 tickets for 5 cents, or 100 for 20 cents, was also carried after some opposition. The rails for the Daft Electric Motor, to be tried on the bridge, are now being delivered, and it is expected that the work of laying them will commence in a few days. Both tracks will be laid with a third rail. Two 50-horse power dynamos will be used in running the motor, which is calculated to be of 65-horse power for drawing one bridge train. The experiments with this motor are to be made between the hours of 1 and 5 A.M.

American Cross-ties; Wood and Standard Dimensions.

A late number of the *Railroad Gazette* contains a valuable and interesting compilation of data upon the important subject of the character and geographical range of the wood used and the standard dimensions of railroad cross-ties.

From this article we condense as follows: The reports received, in answer to a circular letter, cover 90,000 out of the 121,592 miles of railroad now in operation in the United States. Taking first the kind of wood used, we find that $58\frac{7}{10}$ per cent. is white oak; $10\frac{4}{10}$ per cent. cedar; $8\frac{7}{10}$ per cent. yellow pine; $6\frac{3}{10}$ per cent. northern pine; $5\frac{3}{10}$ per cent. hemlock; $4\frac{4}{10}$ per cent. chestnut; and the remaining small proportion is spruce, cypress and miscellaneous hard and soft woods.

In dividing the country into districts as follows: Northeast, South, North Central and Far West, the first division includes New England and the Middle States; the second, Va., South coast and interior and Southwest; the third, Ohio, Ind., Ill., Mich, and northwest of Chicago, and the fourth, the far west interior and the Pacific coast.

In the New England States, nearly one-half the tie-timber is chestnut, about one third is cedar, and the remainder nearly all hemlock. All ties in this district are reported to be 8 ft. long and generally 6 in. thick, the chief exceptions in thickness being the Boston & Albany, and the Old Colony lines, which use 7 in. ties, and the Southeastern with $6\frac{1}{2}$ in.

In the Middle States the timber variation is great. Near New York City chestnut ties are very largely used, and the same timber is employed to the extent of about 25 per cent. on the lines in the extreme west of New York, Penna. and Maryland. In the central belt of New York and Penna. hemlock ties are very general, the proportion ranging from 45 to 85 per cent. By a rude separation we have for oak timber:

In New York 4,945 miles with 42 per cent. oak ties.

In other Middle States 9,164 miles with $82\frac{1}{2}$ per cent. oak ties.

In the Southern States white or rock oak and the "Georgia" yellow pine are the only woods used to any extent. Good heart pine, cut when the sap is down, is reported as lasting in gravel ballast from six to seven years. Only 18 per cent. of Southern ties are as short as 8 ft. and 27 per cent. are 9 ft. long. This is due to the wider gauge, and the fact that long timber is more easily obtained. The thickness of ties on the southern coast is sometimes 6 in. but usually 7 in., and from 9 to 12 ins. wide seems to be the standard. In Virginia and on the lines near the Alleghany Mts. white oak ties, $8\frac{1}{2}$ ft, long and 7 in. thick decidedly predominate.

In the region from Louisville to New Orleans, in the Southwestern States, white oak ties are the rule, though the coast lines use southern pine or cypress very largely. Texas employs white or post oak almost exclusively; Morgan's Louisiana and Texas R. R. is laid with ties 7×10 in. section and 10 ft long. The bulk of the ties in the section are about equally divided between 8 ft. and 8 ft. 6 in. in length; 7 in. is the predominating thickness, only 25 per cent. of the total report being 6 in. On the Cincinnati Southern R. R. 8 ft. ties are used on rock ballast and 9 ft. ties on gravel ballast.

North of the Ohio River, in Ohio, Indiana and Illinois, about the only wood used is white-oak. In Michigan, $53\frac{7}{10}$ per cent. of the ties are oak, the remainder being mostly hemlock and cedar.

In Ohio and Indiana the ties are generally $8\frac{1}{2}$ ft. long. In Illinois the standard seems to be 8 ft. long by 6 in. thick, except on the Illinois Cent. R.R. where ties 9 ft. long and 7 in. thick are found. In Michigan, over half the mileage is laid with 9 ft. ties, the remainder with ties 8 ft. long.

Northwest of Chicago, the ties are almost uniformly 6 in. thick, and 8 ft. long; only about one sixth are 7 in. thick and none are over 8 ft. long. In material used, 48 per cent. are reported as being oak, 37 per cent. cedar and 11 per cent hemlock.

In the Pacific States, red and yellow fir is considered the best timber in Oregon, both as regards its lasting qualities and its spike-holding powers. Oak and ash on this coast, are porous, coarse-grained and short lived and worthless for tie purposes. The cedar is soft and does not hold a spike well. California red-wood is much used for ties and is a serviceable wood. In length of tie, 8 ft. seems to be the maximum,

In Canada, 90 per cent. of the ties are hemlock or tamarack, with cedar on sidings or for light traffic; 8 ft. long with 6 to 8 in. face, and 6 in. thick, appears to be the standard type of tie.

THE Nicaragua Canal project goes on its way in Washington with ever changing fortunes. According to some, it is sure to succeed, others are as certain that it will fail of passage by Congress. Leaving out of the question its supposed vast influence upon prospective American commerce, and its value as an exponent of the doctrine of President Monroe, would it not be well to first ascertain whether the game is worth the candle? With labor at $1.00 per day, Maj. McFarland puts his estimate of cost at $140,000,000. Mr. de Lesseps started at Panama with $1.00, but is now paying $2.00, for about one-fourth of a good day's labor in the North.

Foundation of Pier No. 5. B. & O. Bridge, Havre de Grace, Md.

Our attention has been called to the fact that in the article upon the profile and soundings of the B. & O. Bridge across the Susquehanna River, appearing Jan. 3rd, no mention was made of the novel method used in founding No. 5.

The following description of this work is taken from the Havre de Grace *Republican* and from the official patent office drawings of the invention:—On Feb. 26, 1884, a patent was granted to Mr. J. E. Robinson, of Baltimore, Md., for the construction and operation of caissons for subaqueous foundations. The inventor obtained the contract for sinking the foundation of Pier No. 5. and the following is the method as here applied, according to the paper quoted:

The caisson used was made of iron ¾ inches thick and was 207 feet in circumference. Inside of this shell two rows of sheet piling and one of 8 × 12 inch timber was driven, with an inner series of braced waleing pieces to retain them in position. When this sheeting had been driven into the mud bottom the interior of the coffer dam thus formed was pumped out and the excavation done in the open air. As this was the first application of the inventor's design, and as the rocky bottom was very uneven, many obstacles had to be encountered. The caisson was finally made comparatively water-tight, by caulking presumedly; the leakage amounting to less than 10 gallons per minute.

The depth of water at this point is not mentioned, but judging from the published profile, it did not exceed 10 feet; the material removed to uncover the hard pan upon which the foundation was started was about 5 feet. Two feet of concrete were put under the masonry of the pier, the dimensions of the latter being 20 × 62 feet.

The advantages claimed by the inventor for this new caisson are, economy in first cost; the re-use of all the material; that work is done in the open air and in daylight, and that six men can build this caisson in about four weeks.

Sewage as Fish Food.

Sir John Lawes, in a recent letter to the London *Times*, points out the fact that the discharge of sewage into rivers and into the sea does not necessarily involve a waste of the valuable manurial agents contained therein. He says that without this artificial stimulant, to use an agricultural expression, the German Ocean would hardly be capable of producing the 600,000 tons of fish annually taken from it.

The large fish devour the small ones, and these again feed on those still smaller, but the smallest fish and marine animals find their food in the vegetable growth, which can not be maintained in abundance without a plentiful supply of phosphoric acid. The process involves no special waste, for it is merely a transfer of essential elements—nitrogen, phosphoric acid and potash. Prof. Huxley has stated that an acre of good fishing ground will yield every week more than the equivalent of an acre of farm land, whether it be flesh or grain.

Sir John Lawes argues that, as no land will continue to give crops without the replacing of the material assimilated by the vegetable growth, so the sea would fail in its fish supply unless the chief constituents of animal organism were again restored to it. As evidence in proof he points to the poverty of the fishing grounds on the west of England and the Irish Coast, were sewage discharge is much less than in the German Ocean. Turning to rivers, he mentions several in Scotland whose waters are almost destitute of nitric acid, and in which the trout are exceedingly small; and in two others, where the fish are larger, there is a decided sewage contamination. The River Ver, in Hertfordshire, contains trout of four and five pounds weight, with hardly water enough to cover their backs; but the river springs in the chalk and contains an abundance of nitric acid, and is noted for its water cresses which are manured with superphosphate of lime, again furnishing the elements required in fish culture.

In conclusion, Sir John believes, that as rivers of pure water contain few fish, except at the spawning season when they do not feed, and as seas upon sparsely settled coasts do not furnish profitable fishing grounds, it may be fairly assumed that the nitrogen, phosphoric acid and potash discharged into the fertile rivers are the cause of their fertility.

The theory thus advanced is a comforting one, especially when the engineer has to combat the cry of "willful waste" in disposing of sewage by the most economical and expeditious method. The swarming of fish in waters far remote from the habitations of man is no argument against the theory. If the fish are never removed from their native fluid, their decayig bodies supply the elements required in promoting the necessary vegetable growth; it merely involves a rotation in form, a change of successive condition. In the case referred to by Sir John Lawes, it is the absolute annual removal of hundred of thousands of tons of fish that would eventually diminish the contained elements, and consequently the fish food.

The fact, that fish can not live in water foul with sewage, and that this same sewage, properly diluted, will promote fish culture is a paradox easily understood. In the first case, all the oxygen in the fresh water unites with the sewage in nature's effort to render it innocuous, and none is left to support animal life; in the second case, the sewage, enormously diluted, is not injurious to this life but does promote the vegetable growth necessary to sustain the animal organism of the lower and smaller types; in other words the sewage loses its dangerous character and becomes a valuable manure. It is for this reason that while fish can not live in the River Thames, between Greenwich and Gravesend, the mouth of the Thames forms a fertile fishing ground.

The Annual Report of the Pittsburgh Water Works for the year 1883.

We have just received the annual report of the superintendent of the Pittsburgh Water Works for the year 1883, from which we learn that the total expense of operating the works have been $159,272.64 from which deducting receipts from ferules and scrap sold $2,948.00 leaves the total expense of the department $156,324.64.

In this amount is included the expense of running the old works at the foot of Eleventh Street for a few weeks at a cost of $5,835.66 as well as extraordinary repairs to the new machinery, amounting to $16,422.59 making a total of $22,258.25, which may be classed as unusual expense.

IMPERFECT PLUMBING.

Numerous complaints of house-flooding are made, arising from imperfect plumbing and the use of a cheap class of service pipe, the result of competition among plumbers, who in order to execute their contracts without loss resort to the use of the cheapest grade of materials and fixtures.

It is proposed to license plumbers and to appoint inspectors to examine all service pipes and fixtures, and if the same are not in accordance with the requirements of the department, to refuse connections with the water mains until the objectionable work is replaced.

DAILY CONSUMPTION AND WASTE OF WATER.

The average quantity of water consumed daily during the year 1883 has been 20,280,100 gallons. The daily consumption per *capita* is 186 gallons, which is far in excess of any city on record.

WATER METERS.

There must be a most willful waste, or that parties are consuming large amounts of water for which no remnueration is received. In order therefore to restrict water to its legitimate use, water meters should be used, but in order to obviate a large present outlay, Councils should sanction the purchase of a few different sizes and authorize the superintendent to place them on such service pipes as he might deem expedient.

COST OF PUMPING, ETC.

The number of gallons of water pumped at the Brilliant Works was lowest during the month of April, 1883, namely, 498,542,580, a daily average of 16,618,086 gallons.

The cost of pumping (coal, labor, etc.,) for the same month was $6,081.11, or at the rate of $12.20 for pumping 1,000,000 gallons to the reservoir 356 feet high; the cost of pumping 1,000,000 gallons 1 foot high being therefore $3\frac{37}{100}$ cents.

The greatest number of gallons pumped was during the month of October, 1883, when the daily average was 23,103,290 gallons. The amount expended for coal, labor, etc., during this same period, was $6,897.50, being $9.76 for every 1,000,000 gallons raised to the reservoir, or $2\frac{7}{100}$ cents for every 1,000,000 gallons raised 1 foot high.

The average cost of the whole year was $2\frac{53}{100}$ cents for raising 1,000,000 gallons 1 foot high.

At the Bedford Works 1,000,000 gallons pumped 1 foot high cost $5\frac{23}{100}$ cents, and at the Herron Hill Works $10\frac{37}{100}$ cents.

The height to which water is raised at the Bedford Works is 236 feet. The maximum quantity pumped was during the month of September, 1883, when it reached 4,136,446 gallons daily, while the minimum amount pumped was in the month of April, when the quantity was 2,122,675.

At Herron Hill the water is raised 260 feet, the largest quantity pumped was in September, 1883, 994,346 gallons daily, and in May, the smallest quantity, 777,012 gallons was pumped.

The total cost of pumping, coal, labor, etc., of all the works during the year was $102,615.19. The total number of miles of pipe laid at the end of the year was a little over 134 miles. The number of gates was 1539, and the fire hydrants 865.

It may be well to say here that the fiscal year of the city of Pittsburgh, and to which the report conforms begin with the month of February, and ends with the month of January of the following year.

The Pittsburgh Water Works only supply the 23 wards lying between the rivers Alleghany and Monongahela, the other 13 wards lying at the southside being supplied by the Monongahela Water Works Company, a private corporation.

PERSONAL.

M. FRANCOIS ELIE ROUDAIRE, the French hydrographer and the projector of the African Inland Sea is dead. He was 48 years of age.

J. R. KENLY has been appointed General Superintendent of Transportation for all the roads included in the Atlantic Coast Line. H. B. Dunn is also appointed Engineer to the same system, vice Mr. Kenly promoted.

ALEXANDER MCCUE, Ex-judge of the City Court of Brooklyn, and one of the original Trustees of the Brooklyn Bridge, was elected on Jan. 10, a Bridge Trustee to succeed William C. Kingsley, the retiring President of the Board of Brooklyn Bridge Trustees.

JAMES MOYLAN, C. E. formerly of the N. Y. W. S. & B. R. R. has just been appointed engineer in charge of maintenance of way on the Atlantic & Pacific R. R. from Albuquerque N.

M. to Mojave, Cal. Headquarters will probably be in the first named town.

PHILA. AND READING OFFICERS FOR 1885. At the annual meeting of the company in Philadelphia, Jan. 12, the following were elected officers of the road for the present year:—Geo. De B. Keim, President; J. B. Lippincott, J. V. Williamson, Franklin A. Comly, Joseph Wharton, John Wanamaker and Robert H. Sayre, Managers,

CHARLES C. SMITH, Chief Engineer of the St. Paul, Minn. and Manitoba R. R. since 1881, has resigned. Mr. Smith located part of the St. Paul and Pacific Railway and was subsequently connected with the Lake Shore and Michigan Southern, the Indianapolis, Bloomington and Western, and other roads previous to 1881.

PROF. BENJAMIN SILLIMAN, of Yale College, died at New Haven, on Jan. 14, of heart disease. Professor Silliman, was born in New Haven, December 4. 1816; graduated from Yale in 1837, and since that time has been connected with that college as assistant, and finally as professor of chemistry. His many and important contributions to science are too well-known to require further remark.

ANDREW C. GRAY, President of the Chesapeake and Delaware Canal Co., since 1854, died on Jan. 10. Mr. Gray was born in Kent Co., Del. in 1804; graduated at Princeton College in 1821, and commenced the practice of law. But from 1850 he had been actively engaged in developing the resources of his native state; he was the prime mover in the construction of the Delaware R. R. and developed and raised from a bankrupt condition the canal of which he was so long the chief officer.

HENRY LAWRENCE EUSTIS, late Professor of Engineering in the Lawrence Scientific School, Harvard University, died on Jan. 11. Mr. Eustis was a son of Gen. Abraham Eustis, and was born at Fort Independence, Boston Harbor, Feb. 1, 1819. He graduated at Harvard in 1838, and was appointed to West Point same year, graduating in 1842, in the Engineer Corps. From 1847 to 1849 he was Assistant Professor of Engineering at West Point. He resigned his commission in the army Nov. 30, 1849, to accept the position at Harvard, which he held at the time of his death. He served two years during the Rebellion, and was breveted Brigadier General of volunteers, June 27, 1864.

OBITUARY.

John Bloomfield Jervis.

John Bloomfield Jervis, a veteran among American civil engineers, died at his residence at Rome, N. Y. on Jan. 13.

Mr. Jervis was the son of Timothy Jervis, one of the early settlers of Rome, Oneida Co. N. Y., and was born in Huntington, Long Island, on December 14, 1795. His boyhood was spent in Rome, assisting his father in the daily labor of the farm. He attended the district school until he was fifteen years of age, and he left his books to commence life as a farmer, which he then supposed was to be his future permanent occupation.

But in 1817, ground was broken for the Erie Canal, and, as the line was located through the village of Rome, young Jervis and one of his father's axemen found themselves engaged in assisting to clear the way; the young man's curiosity was aroused, he became interested in the work going on about him, and it ended in his making an engagement with the engineer in charge to enter the service of the company as a rodman at the magnificent salary of $12 per month.

Mr. Jervis rose rapidly, and in the spring of 1819 we find him appointed resident engineer of a portion of the middle division, in Madison and Onondaga Counties. From that time until the completion of the canal in 1825, he was in the service of the Erie Canal Co. in various capacities. In March 1825, he was Principal Assistant Engineer of the Delaware and Hudson Canal and Railroad Company, and rendered important service in the projection of a line of communication between the Lackawanna coal mines and New York City; he favored an independent canal throughout and this was finished in 1828. In 1830, Mr. Jervis, who was then the company's Chief Engineer, resigned, to superintend the construction of a railroad from Albany to Schenectady, now an important link in the New York Central system.

In 1836, Mr. Jervis was offered by the Commissioners the position of Chief Engineer of the projected Croton Aqueduct for the supply of New York City, and accepting the charge, for six years was actively engaged in the important engineering duties involved. The Croton Dam, the Sing Sing and High Bridge, and the Forty-second St. Reservoir remain as monuments of his professional skill in construction.

Mr. Jervis was, previous to 1848, consulting engineer for the Cochituate Water Works in Boston, and was for a time Chief Engineer of the Hudson River R. R. Co., but resigning this position in 1849, he was retained as Consulting Engineer.

In 1850 he spent four months in Europe, and was a witness to the launch of one of the tubular spans of the great Menai Straits Bridge. Upon his return to the United States he directed the construction of the remaining link of the Michigan Southern and Northern Illinois Railroad. In 1851, as President of the Chicago and Rock Island R. R. he commenced that important line. In 1861 he was General Superintendent of the Pittsburg, Fort Wayne & Chicago R. R., and continued to act as engineer of the last named road until 1866. Since the last date he had to a great measure retired from the active practice of his profession, though he to the last took a lively interest in its advancement.

In 1832, Mr. Jervis invented and had built by Robt. Stephenson, in England, the "Experiment," an engine with a single pair of drivers in the rear on an axle attached to the main frame, and with a four wheeled swivelling truck in front, operating with a free motion, and guided, restrained and controlled only by the flange action of the wheels against the rails. This "Experiment," with its guiding truck or "pony," ran with ease on curved or straight track, and was the forerunner of the present type of locomotive, the number of driving-wheels having since been increased to meet the demand of greater weight in the engine, more speed, and less destructive effect upon the track.

Mr. Jervis was elected an Honorary Member of the American Society of Civil Engineers, Dec. 2, 1868, and was the author of a book on "Railway Property" and another on "Labor and Capital." He was conspicuous for his Christian character, his benevolence and his strictly upright course in life.

American Society of Civil Engineers.

Programme for Annual Meeting.

The Annual Meeting of the Society will be held January 21st and 22nd, 1885, at the Society House.

WEDNESDAY, JANUARY 21ST.

The meeting will open at 10 o'clock. The Annual Reports will be presented; officers elected; the awards of the Norman Medal, of the Rowland Prize for the last year, announced; proposed amendment to the Constitution discussed, and, if so determined, amended; the replies from members to the circulars in reference to conventions will be presented; the proposed regulations as to the presentation, reading and discussion of papers at conventions submitted; the time and place for the next Convention considered; reports from Committees on technical subjects presented and discussed.

Lunch will be served at the Society House at 13.30 o'clock (1.30 P.M.) After lunch the Session of the Society will be resumed.

In the evening a meeting will be held. Some of the special features of the points to be visited on Thursday will be explained and illustrated by drawings. The technical reports may be discussed. Probably a few short addresses will be made by members.

THURSDAY, JANUARY 22D.

Members will meet at the Society House at 9 o'clock, and proceed thence to the *New York Station of the Consolidated Gas Company* at the *foot of East 21st Street*; or if more convenient, the party may be joined at the station at 9,30 o'clock. By invitation of the *Consolidated Gas Company*, tendered through Mr. T. F. Rowland, M. Am. Soc. C. E., the Works will be inspected and the latest methods of manufacturing water gas will be explained.

Leaving at 10.30 the party will go by the Elevated Railway to the Battery, and by the Atlantic Ferry to Brooklyn, where, by invitation of the *Owners and Lessees of Dow's Stores*, tendered through Mr. George B. Mallory, M. Am. Soc. C. E., an inspection will be made of these Stores and Grain Elevators, and of the distribution of power by wire rope transmission. Dow's Stores are at the *foot of Pacific Street, Brooklyn*, quite near the Atlantic Ferry. The party will arrive there about 11.30. and will leave there at 12.30, proceeding to foot of Whitehall Street, New York.

At 12.45 arrive at the *Washington Building, No. 1 Broadway*, where by invitation of Cyrus W. Field, Esq., tendered through Mr. William G. Hamilton, M. Am. Soc. C. E., a general inspection will be made of this building, and an opportunity given for enjoying from the roof the extended view of the City and the Harbor of New York.

The Secretary is requested by Cyrus W. Field, Esq., to extend to the Members of the Society an *invitation to lunch with Mr. Field*, at the Washington Building, at 13.15 o'clock (1.15 P.M.) The invitation has been accepted by the Committee, in behalf of the members.

Leaving the Washington Building at 14.15 o'clock, proceed to the *Produce Exchange*, by invitation of the President of the Exchange. The building will be inspected under the escort of the *Building Committee* and of George B. Post. Esq., the architect of the building, and of Mr. Thomas E. Brown, M. Am. Soc. C. E., who will exhibit and describe the very complete elevator service. Leaving the Produce Exchange at 15.15 o'clock, proceed to the *Terminus* of the *New York and Brooklyn Bridge*, where, at 15.45 o'clock, the machinery and the Bridge will be examined, under the escort of the *Engineers of the Bridge*. Crossing the Bridge to the New York Terminus, proceed *via* Elevated Railway, to the Central station of the *United States Electric Illuminating Company* at 36 *Stanton Street*, which is near the Bowery, and one block below Houston Street, arriving at that station at about 17 o'clock (5 P.M.) Here the very large plant of this Company will be exhibited in operation, under the escort of its officers.

On *Thursday evening*, at 20 o'clock, a reception for gentlemen will be held at the House of the Society, and at 21.30 o'clock (9.30 P.M.,) Supper will be served in the Library.

F. COLLINGWOOD,
D. MCN. STAUFFER,
JOHN BOGART,
Committee.

American Institute of Mining Engineers.

New York, January 10, 1885.

The Annual Meeting of the Institute will be held in New York City, beginning Tuesday evening, February 17. Mr. David Williams, 83 Reade Street, is the Chairman, and Mr. William H. Wiley, 15 Astor Place, is the Secretary of the Local Committee of Arrangements. The headquarters will be at the Park Avenue Hotel, Fourth Avenue and 32nd and 33rd Streets, where a special rate $3 per day for rooms and board has been secured for members. Application for rooms should be addressed to Mr. Henry Clair, Park Avenue Hotel.

Members intending to be present at the meeting, and also those having papers to present, are requested to notify the Secretary of the Institute as early as practicable. No special railway facilities are to be expected for this meeting. Further particulars concerning the meeting will be given in a subsequent circular.

On the 2nd of January a package was mailed to each member and associate, stamped "Pamphlets, Dec. 31, 1884," and containing the following fifteen papers, viz.:

1. The Electrical Activity of Ore-Bodies, by Carl Barus.
2. The Iron-Ore Range of the Santiago District of Cuba, by J. B. Kimball.
3. Notes on Coal-Dust in Colliery Explosions, by E. S. Hutchinson.
4. Quicksilver Reduction at New Almaden, by S. BChristy.
5. The Improved Langen Charger, by Frank Firmstone.
6. Note on a Fire-Bulkhead, by Charles M. Rolker.
7. Notes on the Treatment of Nickel-Cobalt Mattes at Mine la Motte, by James W. Neill.
8. The Deep River Coal-Field of North Carolino, by H. M. Chance.
9. Hadfield's Patent Manganese Steel, by J. D. Weeks.
10. A New Rock-Drill Without Cushions, by A. C. Rand.
11. American Mining Machinery in Mexico and Central America, by F. A. McDowell.
12. Progress of the Manufacture of Soda by the Ammonia Soda Process, by O. J. Heinrich.
13. Geology and Mineral Resources of the Rio Grande Region in Texas and Coahuila, by E. J. Schmitz.
14. The Iron Mines of Putnam County, N. Y. by Arthur F. Wendt.
15. Experiments with a Straight or No-Bosh Blast Furnace, by W. J. Taylor.

Any member or associate who has not received the above papers is requested to notify the Secretary *immediately*, as it may be impossible, after a limited period, to remedy such a loss.

IV. Members and associates in arrears for dues are requested to make prompt remittance.

R. W. RAYMOND,
Secretary.

THE Nicaragua canal engineering party arrived at Managua on Jan. 10 and visited the president, who received them cordially.

How Gun-Cotton is Made.

It is not generally known that there is but one place in the United States where gun-cotton is manufactured, but such is the case. The navy, up to six months ago, was obliged to depend upon England for all the gun-cotton used. It was decided to erect a manufactory at the torpedo station in Newport Harbor, Rhode Island, and in due season it was in successful operation and is now able to supply all that is required for sea-going men-of-war and torpedoes. In the manufacture of gun-cotton the best cotton waste and the strongest and purest nitric and sulpheric acids are used for the explosive. There is only one manufactory in this country that can supply the sulphuric acid. The cotton waste, after it has been handpicked for the purpose of removing the dirt and grit, is placed in boiling tanks, where it is allowed to remain for four hours. It is afterward subjected to a thorough washing and is reboiled. This operation removes all oily matter and leaves the cotton harsh and stiff. It is then dried in rooms heated with the waste air from a drying box. After undergoing this treatment the cotton rolls up into snarls and bunches, and in order that the acid may have a freer access to it it is passed through a shedder and converted into a fluffy state. It is afterward exposed in an air-tight box for several hours to a temperature of 200°, which practically deprives it of all moisture. From the air-tight box it is removed to the dipping-room, where there are iron troughs filled with one part nitric acid and two parts of sulphuric acid. Into these troughs the cotton is placed, one bundle at a time, and allowed to remain about 10 minutes, long enough for it to be thoroughly soaked. The acid is hardpressed from the cotton, which is then placed in covered earthern jars, where it remains 24 hours, undergoing chemical transformation. In view of the fact that much heat is evolved during the chemical reaction, it is found necessary to place the jars in pots and surround them with flowing water, which serves to keep them cool.

The cotton is now nitrated, and is practically gun-cotton, but the acid, still mechanically held, must be wholly removed, or it would be apt to quickly deteriorate and become extremely dangerous. The charges, therefore, are taken one by one and placed in an acid wringer and plunged into a large tub which is kept filled with running water, in which a large wheel is rapidly turned in order to subject the cotton to a thorough washing. This latter process is continued till no acid is perceptible to the taste. It is then subjected to a still further washing and boiling in an alkaline mixture, this being necessary in order to remove every trace of acid. The cotton is now in long shreds and balls, which can be used or stored without danger, the processes of conversion and cleansing being completed, but for military use it must be put into a more compact form. For this purpose the gun-cotton, in charges of 300 pounds, is thrown into a pulping tub, where, mixed with water, it is ground by steel cutters into a fine pulp. The grinding and breaking up of the cellular tissue of the cotton has made it more or less dirty, and it is necessary, therefore, to expose it to frequent washings in the poaching-tubs, from which, after treating it with limewater to make the moisture slightly alkaline, it is drawn up into a large iron tank, where it is fed to the molds, which, under a moderate pressure, pass the water from the pulp and trim out cylinders of cotton about 8 inches high and 3½ inches in diameter. These cylinders are then placed under a hydraulic press and exposed to a pressure of about 1700 pounds to the square inch, or about 8 tons on each. The cylinders are pressed into hard cakes or disks, some 2 inches high and 3½ inches in diameter, with a specific gravity a little greater than water. They are then packed in boxes of 50 pounds each and kept in magazines for general use. Gun-cotton, is from its great explosive power and the conditions of safety attached to its storage, superior to any other known explosive for naval warfare. Since the introduction of gun-cotton the gun-cotton torpedo system has been introduced at the station. These torpedoes now take the place of the heavy, unwieldly gunpowder torpedoes, which, with their charges, weigh 380 pounds. The gun-cotton torpedo only weighs 75 pounds.—*Exchange.*

TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page 27.*)

Joints.—The weakest part in the track is the joint, the one detail which above all the rest needs most attention and time in order to insure a smooth and easy riding track. For a joint to be perfect it should be; First, as strong and elastic as the rail itself. Second, the parts should be simple, readily replaced and permanently secure.

There is no joint which entirely fulfills the above requirements, and to appreciate the difficulty of the problem one need but watch the pounding of a passing train on what at present appears to be the necessary gap at every joint. Suddenly from its state of rest the joint is disturbed by a blow of 7 tons on a driver travelling at the rate of 40 miles an hour. Then will come a series of rapidy delivered blows ¾ to 1½ tons each at irregular intervals as the body of the train passes over, and again suddenly is the weight taken off and the joint allowed to settle back to rest through a series of hurtful vibrations. Perhaps, after this will follow a slow, heavily loaded freight train, where the effect of the ponderous "consolidation" will be one of slow pressure rather than the decisive blow of the express "flyer," and behind it come with varying intensity of weight and force 250 wheels of the following train. This incessant hammering, at all times greatly varying both in weight, intensity of force, and rapidity of repetition, the joint is expected to stand.

Under the requirements of a perfect joint the quality of strength is easily understood, and by elasticity is meant that inherent power of bodies to return to their original shape. Thus as a wheel rolls over a rail the rail is depressed and by its own elasticity and that of the ballast it returns to its former position after the wheel has passed by. To say therefore that the joint must be equally elastic with the rail means that it will depress under passing loads to the same extent and also spring back equally to its former position. It is keeping the joints in order that takes such a large percentage of track labor. The incessant pounding they are subjected to, their lack of strength and elasticity and the tendency of the parts to loosen soon make a joint begin to sag. Therefore all the more can be appreciated the importance of keeping the road in good order, and especially the ballast perfectly drained so as to ensure the joints as firm a foundation and constant condition as possible in order to best withstand the necessary varying blows.

Joints are of two kinds, supported when a tie is immediately under the joint and suspended when the joint falls between two ties. The theory of the first is that resting on a tie a direct substantial bearing is obtained to resist the blow of the wheel as it strikes the expansion space. In practice however, since the joint must be solidly tamped, this blow must be transmitted to a hard inelastic foundation especially when the ground is frozen.

The effect is of a shattering nature and a series of repetitions loosens the tamping and gradually the joint gets "low." With the suspended joint however the blow is first taken up by the rail and fastenings which act as a cushion, and it is transmitted both ways to the two ties which support it. Of course the fastenings should be of sufficient strength to act as a girder otherwise the rail will bend. But with properly proportioned fastenings and by keeping them tight this tendency to weakness is overcome. In winter when the ground is frozen and has no elasticity at all, the supported joint is entirely without spring and adds to the general jar. That this view of the two joints is correct I have repeatedly seen demonstrated by noting the action of them both under precisely similar circumstances.

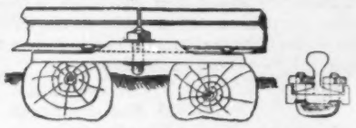


FIG. 38—THE FISHER JOINT.

The earlier shapes of "T" rails as the Pear section had the joints necessarily held in chairs of either cast or wrought iron shown in figures 36 & 37. The great objections to these chair joints are first, that they are necessarily supported which, in addition to the already mentioned disadvantages, is frequently annoying when laying new rails over old ties as it necessitates the moving of the ties to catch the joints unless the new rails are the same length as the old. Secondly, a perfect fit between rail base and chair is impossible, consequently there is incessent clatter. Thirdly unless all bearings are true and joint in surface either the chair of cast iron is liable to crack, or else the corners of the rail base will break off and permit side motion in rail ends. Creeping of the rails with these joints is prevented by spiking both chairs and rails together to the ties by means of holes made in the chairs (see figs.) and slots punched in the base of the rails to correspond.

The class of chair joints has been improved in several ways, the best of which improvements are contained in the Fisher joint, Fig. 38.

Its advantages are that it is a suspended joint and has its material distributed economically, since it is all at the bottom of the rail thus virtually adding to its depth; it moreover gives support to the whole end of the rail which cannot deflect until the chair does. The Fisher joint is held by a much larger bolt than can be safely put through the web of a rail and therefore permits the nut to be screwed down with greater force. This vertical bolt also prevents creeping since the rails butt against it, the corners being drilled off to receive it.

This joint like all chair joints, or any other which like them in part or whole lies between the rail and tie has one great disadvantage. The joint ties must be cut down, giving a tendency to split and extra liability to rot, or else they must be lowered. If they are lowered i is done by inclining them (unless the joints are "opposite"), when the surface of the ties and that of the rail base are no longer in parallel planes giving the joint uneven bearing. Secondly all chair joints are noisy. It is impossible to keep track in such shape that the rail will not rattle in the chair especially after wear. The first step in advance over the old-fashioned chairs was the Fish-plate which began to come in general use in 1847. Two straps of iron bolted to the rails. as in Fig. 39 and receiving its name from the sailor's term of "fishing" a joint on the same principle. They vary in length from 15 to 20 inches, in height according to rail section and in weight from 8 to 14 lbs. a piece. They are held by 2, 4, or 6 bolts, generally 4. The spacing of these bolts follows no rule but varies arbitrarily with each road. Such a joint can be either suspended or supported but unless the plates are very heavy and traffic light it is best to use them supported. The metal is not well distributed to give much vertical strength and if they have to carry weight, as in a suspended joint, they will break. To prevent this breaking a plate reinforced in the center called the Samson bar, has been invented. To prevent creeping with the Fish-plate joint the corner of the base is cut away sufficiently to hold a spike or else back from the end a proper distance in case a suspended joint is required. Sometimes however, instead of cutting away the corners, slots are punched about 2 inches back from the end so that there is room for the slots of both rails on the same tie.

This gives 4 spikes instead of 2 to the joint.

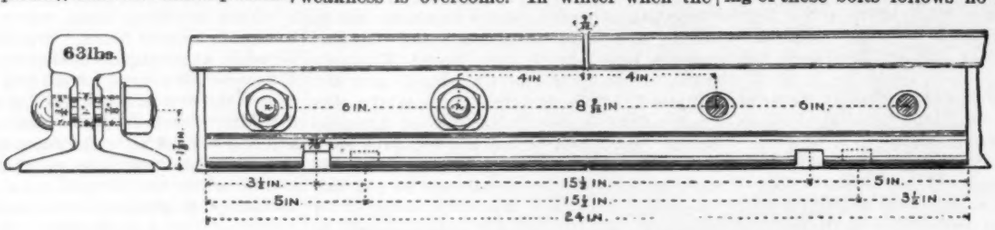


FIG. 41—STANDARD JOINT, N. Y. L. E. & W. R. R.

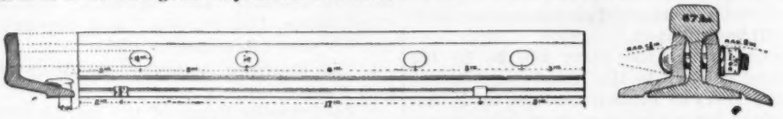
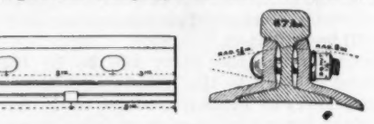


FIG. 42—STANDARD JOINT, PENNA. R. R



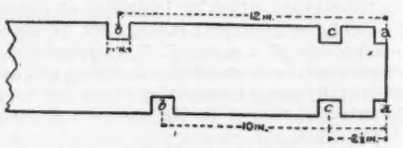


FIG. 40—SLOTS IN BASE OF RAILS.

Fig. 40 shows the three styles marked respectively a, b, c,. If a rail is spiked in warm weather, the spike must be driven on that side of the slot away from the end of the rail thus allowing the rail to contract and expand, though in narrow limits. In order to give a plate joint sufficient strength to act as a suspended joint an angle bar weighing from 15 to 20 lbs. a piece instead of a straight bar is used as shown in Figs. 41 and 42 the standard joints of the N. Y. L. E. & W. R. R. & P. R. R. respectively. Such a joint, varying only in details of size of plate and spacing of bolts, is the generally adopted standard of the day and hence claims our attention at length.

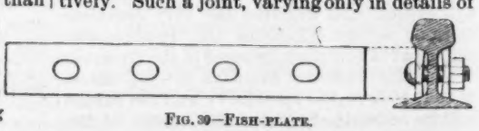


FIG. 39—FISH-PLATE.

The first advantage over the straight splice is obtained by having the increase of metal at the bottom adding to its vertical strength and

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thus justifying its use as a suspended joint. Again the strength of the joint is materially

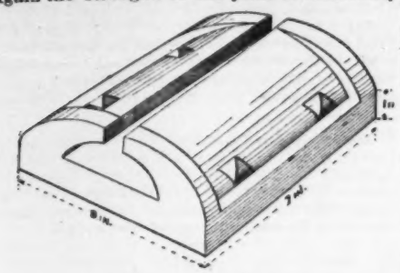

FIG. 36—CAST-IRON CHAIR.

increased laterally, for rails have not only to resist vertical but lateral strains as well and on a curve, unless they are carefully bent

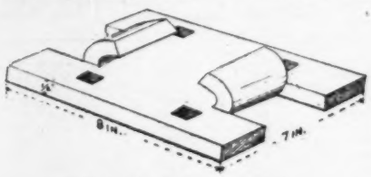

FIG. 37—WROUGHT-IRON CHAIR.

previously, they tend to straighten and obtain the amount of curvature by deflecting at the joints. This tendency is counteracted by the lateral stiffness of the angle bar.

(TO BE CONTINUED.)

CORRESPONDENCE.

The Potomac Falls and Neighborhood.

GREAT FALLS, MD., JAN. 12, 1885.

EDITOR ENGINEERING NEWS:—While employed at this place I have made some notes which may be of interest to other readers of ENGINEERING NEWS.

The past year has been one of unusual activity. Chittenden Bros. have been at work on the new dam across the Potomac for the Washington Aqueduct Extension, of which they have built about 1,200 ft. in length. The total length of dam, new and old, when completed will be 2,900 ft. the greatest height 18 ft. The bed of the river is blue gneiss which gives an excellent foundation. The specifications declare:

"The dam will be 8 ft. wide at top, with a vertical face down stream, the up stream face having a slope of two vertical to one horizontal.

The down stream facing, and the up stream facing for a depth of two courses below the coping, will be laid in regular courses not less than 12 in. in thickness. The stone will be not less than 4 ft. long and 3 ft. wide; they will be dressed to give mortar joints of not more than ¾ of an inch, beds horizontal, and vertical joints perpendicular to beds and face; they will be quarry faced, with a draft of 1 in. along the face edges."

And for the coping: "Each stone will be 8 ft. 3 in. long, 15 in. thick, and not less than 4 ft. wide; they will be laid entirely as through headers, each stone covering the entire width of dam and projecting 3 in. beyond the down stream face." The body of the dam is of concrete. The old dam will be repaired and a coping course placed upon it. The stone is a hard sand stone from the government quarries at Seneca, Md. These quarries supplied the stone for the bridges of the Washington Aqueduct, with the exception of the granite ring of the Cabin John Bridge.

Without devoting any time to this already well described bridge, I would however call attention to a beautiful elliptical arch of 75 ft. span, somewhat more than a mile further up the conduit, known as Bridge No. 3. This little bridge should not be forgotten when one is visiting the big one.

On the Maryland side, about three miles from the dam is a gold mine worked on a small scale. Here you can see a "long-tom," a stamp-mill, a roasting furnace, a number of shafts full of water and an old miner, who never lets a drop of water pass till it has washed the precious sands for him. It pays. There is a deserted mine and several prospects in this neighborhood.

On the Virginia side and within three miles of the dam are two soap-stone quarries, one of them, which is but partly opened, has a 6 in. vein of asbestos crossing it; a serpentine quarry also partly opened, a deserted iron mine (magnetic ore,) the Falls, and an old canal.

This old canal is the one particular thing I intended to describe when I began, and now I will make my description as brief as possible. Rumor says Gen. Washington made the survey before the Revolutionary War, and built the canal just after that war; also that no boat has passed its locks in the last sixty years. It was about one mile long and had six locks. Four of these locks overcame a fall of 50 ft.; I could not get to the other two locks to measure them on the day I visited the canal. The lower four were blasted out of the solid rock and had only one gate apiece, each lock discharging directly into the one below it. The masonry of the upper two is nearly all in place, and an oak center post of one of the lower gates is still standing erect. A number of trees are growing in the masonry, some of them more than 1 ft. in circumference.

S. B. MERRILL.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E. : M. INST. C. E.

Continued from page, 28.

DCCVII. CATSKILL, N. Y.

Catskill, Greene County, New York, in lat 42° 20′ N. long. 73° 40′ W., is on hilly ground on the west bank of the Hudson River at the mouth of Catskill Creek. Water-works were built by the village in 1884 after plans and under the superintendence of W. S. Parker, C. E. taking the supply from the Hudson River about a mile above the village and pumping by two Davidson compound condensing steam pumps, steam cylinders of 16 and 30 inches diameter and water cylinders 12 inches diameter, all of 24 inches stroke, into a reservior 250 feet above the river, constructed in excavation and embankment, 256 × 146 feet at water surface and 20 feet deep. One side of the reservoir and part of the bottom is in rock excavation. When the reservoir was filled, in August 1884, the water passed through or under the embankments and saturated the gravelly soil south of the reservoir for several hundred feet, coming to the surface in springs at every depression. No remedy for this has yet been adopted.

Distribution is by 8½ miles of cast iron pipe of from 10 to 4 inches diameter, with 87 fire hydrants and 72 taps.

The works have cost $135,000, which is the bonded debt at 4 per cent. interest. The population in 1880 was 4,320.

The works are managed by the village trustees. E. Lampmann is President.

DCCVIII. CORTLAND, N. Y.

Cortland, New York, in lat. 42° 35′ N., long, 76°15′ W., the County Seat of Cortland Co., is on the Teoughnioga River.

Water-works were built in 1884, by a private company.

The supply is taken from a sphinx which yields 1,000,000 gallons daily in the dryest seasons, and is pumped through a 10 inch cast iron pipe for 1700 feet by a Worthington Compound duplex condensing pump of 14 and 20 inch steam and 12-inch water cylinders, and 15 inch stroke to a plate iron tank 40 feet in diameter and 40 feet high, 125 feet above and ½ mile distant from the main street of the town. When necessary the water can be pumped direct into the mains.

The works went into operation in September, 1884, and one month later the distribution was by 7 miles of cast iron pipe of 12 to 4 in. diameter, with 40 fire hydrants and 225 taps. Wrought-iron is used for services.

The cost of the works has been $115,000. The bonded debt is $55,000 at 6 per cent. The town pays $50 yearly for each hydrant. The population in 1880 was 4,050, and is now said to be 6,000.

The officers of the company are J. E. Eggleston, President, E. Keaton, Treasurer, and J. S. Bull, Secretary and Superintendent.

DCCIX. ELDORA, IOWA.

Eldora, Iowa in lat. 42° 20′ N., long, 93° 5′ W., is on the Iowa River.

Settled in 1852 it was incorporated a city in 1868.

Water-works were built by the city in 1883, after plans of W. H. Burnham taking the supply from a well 10 ft. in diameter and 40 ft. deep, in the bottom of which a 6 inch tube is driven to a depth of 100 ft., yielding 4,000 gallons daily. A double acting pump of 4 in. bore and 12 in. stroke made by W. S. Wind Engine and Pump Co., driven by a Halladay wind-mill 22 ft. in diameter, lifts the water to a wooden tank 30 ft. in diameter and 20 ft. high, raised 40 feet above the surface of the ground on a timber trestle.

Distribution is by 3,000 feet of cast iron pipe of 6 to 4 in. diameter with 6 fire hydrants and 8 taps. Service pipes are of wrought-iron. The works have cost $800. The bonded debt is $6,000 at 7 per cent. The population in 1880, was 1,584 and is now given as 2,000.

Up to this time the yearly cost of maintenance has been nominal and the receipts $100.

T. G. Alvord is Chairman of the Water-works Committee and J. S. Hadley is Superintendent.

WATER.

A 1,500,000 iron pipe tank is to be erected, at Charleston, S. C., by the Charleston Water Company.

THE Lorain, Ohio, water-works were satisfactorily tested on Jan. 8. They were tried up to 150 lbs. pressure.

PULASKI, TENN., is to have a new water-works. A much needed improvement.

EUSTIS, FLA., will try artesian wells for a water supply. The boring will be done by the Eustis Artesian Well Company.

WHILE boring an artesian well on the Rosecrans tract, near Los Angelos, the workmen discovered a deposit of conch shells at a depth of 160 feet.

A PRESS report from Pittsburgh says that cast-iron pipes will not convey natural gas. It is in order to state why and give further facts, if they exist.

THE New York City Water Co., has been incorporated: capital stock, $500,000; purpose "to bore and dig for and accumulate" water for power and fire purposes.

THE new Croton Aqueduct Commission have directed the Comptroller to issue $1,500,000 additional water bonds to meet the in-coming estimates for work done in the next six months.

IT is stated that the secretary of the New Orleans Water Company has succeeded in obtaining a solution of iron, one pound of which will perfectly clarify 4,000 gallons of Mississippi river water in twelve hours, at a cost of 25 cents.

CHIEF LUDLOW, of the Philadelphia Water Department is cramped for room for his clerical force and wants the city to rent a church building near by until the quarters in the new City Hall are completed.

DURING December the average daily consumption of water in Duluth, was 239,856 gallons, a monthly consumption of 7,373,552 gallons. During the year 1884 the pumps ran 3,946 hours, consumed 579 tons of coal and pumped 105,580,208 gallons.

THE Holly Manufacturing Company of Lockport, N. Y. have secured the contract for a Gaskill Compound Condensing Pumping Engine for Leavenworth, Kan. Water-works of 4,000,000 gallons per 24 hours capacity, with a guarantee of 90,000,000 foot pounds duty.

NEWARK, OHIO, will submit to its citizens the question of water-works at an election to be held Jan. 31. The question to be decided is the voting of $150,000 in bonds for a reservoir system of water-works. The citizens have twice before voted against it.

THE Silverton Water Co. of Silverton, Colorado, filed articles of incorporation last week. The capital stock is $100,000; incorporators, T. C. Henry, H. J. Aldrich, and A. B. Coulson. The principal office is in Denver, Colorado.

AT a recent irrigation convention held in Fresno, Cal., the delegates represented irrigation works and interests dependent upon them valued at $55,000,000, all of which interests are in Southern California and all developed during the past fifteen years.

PIPES for the conveyance of water under high pressure are now being made in England from steel plates. These are coated with lead on both sides, by immersion or otherwise, then rolled into form, riveted, soldered the whole length and covered with pitch.

A MR. HANNAHS has submitted to the Chicago City Councils a proposition for disposing of the city sewage. His idea is to construct an open conduit from the city south to a point twelve miles distant; terminating in a reservoir from which it is to be lifted by pumps into the Desplaines River. By this plan he agrees to empty the Chicago River, which now receives the sewage, once in 24 hours. The work is to cost $1,400,000.

THE LEXINGTON KY. WATER-WORKS were completed and satisfactorily tested on the 1st instant. Preparations for a grand display of fire streams with inauguration ceremonies to occur at an early day, are in progress. The water is taken from storage reservoirs two miles from the city of about 90,000,000 gallons capacity, which are supplied from water-shed and springs, and pumped direct to the city.

CHAIRMAN SIMMONS, of the Boston Water Board, states that the increase in the water tax is due to the adoption of new rules in assessing the tax, which better adjust the burden between large mansions and the houses of those of moderate means. Ex-mayor Martin, however, expresses his surprise at the increase, and declares there is no reason for it, as the tax last year produced $100,000 surplus.

S. W. CLARK, engineer of the Duluth Water and Gas Co., of Duluth, Michigan, sends us the following report of these works for the year 1884:—The pumps are two Geo. F. Blake duplex compound, of one million gallons capacity each; they were started on Nov. 1, 1883, and since then have not required the outlay of one cent for repairs, aside from a few valve springs and packing. For the year ending Dec. 31, 1884, the gallons pumped were 105,580,208; the hours run, 3,946; fuel consumed 579 tons; average pressure, 91½ lbs.

LOCH KATRINE WATER.—The monthly report of the quality of Loch Katrine water, prepared by Professor E. J. Mills, D. Sc., F. R. S., Anderson's College, has just been issued. The results are returned in parts per 100,000:—Total solid impurity, 3.06; organic carbon, 0.140; organic nitrogen, 0.022; nitric nitrogen, 0.005; ammonia, 0.000; total combined nitrogen, 0.028; hardness, 0.95; chlorine, 0.70. Temperature, 5.8° C. (= 42.45° F.) The water was sampled on December 15. It contained very little suspended matter.

AT a special election held Jan. 12, the citizens of Ravenna, Ohio, passed upon two propositions submitted by the Council for building water-works, the first to authorize the Council to issue bonds not exceeding $75,000 and build the works, the second to authorize the Council to permit a company to build the works and contract with said company for the water required by the city for a term of eight years at a cost not exceeding $4,000 per annum. The first proposition was carried by a majority of 256. The second proposition was defeated by a majority of 10.

A SPECIAL committee of the Lowell, Mass., Water Board has reported that the filtering gallery constructed at considerable expense so many years ago is of no practical value, and recommended that some method of filtration or supply from artesian wells should be devised to yield pure water, with arrangements that the water so pumped may be kept in the settling basin until ready for use. It also recommended that the reservoirs be so connected as to be frequently and thoroughly cleansed. The total exdenditures of the water department for the past year, including interest, were $174,552.81; total receipts, $154,437.55. It was voted to recommend to the City Council the enactment of an ordinance licensing plumbers.

MR. EMIL KUICHLING, C. E., of Rochester, N. Y., in an interview published in the Rochester *Herald* finds a practical difficulty in carrying out the suggestions of George E. Waring, Jr., advocating the abolition of traps in lateral sewers under certain conditions. Mr. Waring believes that if a house drain is tight and a soil pipe be used, ventilation of public sewers will be complete and an exterior trap will not be required.

Mr. Kuichling says that the inequality of height in the houses of our American cities is a serious objection to this plan. No resident will care to breathe the air issuing from the soil pipe of an adjoining lower house, and, to make such a plan feasible, the soil pipes must all be carried to the same height, either by independent construction, or by running up the wall of the higher building. As such a pipe at the least would hardly be considered ornamental, the tenant would again naturally object.

THE ELKHART WATER WORKS, INDIANA.—These works were built in 1884, by the Elkhart Water Co. Water is taken from a curb well 30 feet in diameter, near the Christiana Creek; the curb is brick, 16 in. thick, with an iron shoe, and is sunk 26 ft.; leaving 7 ft. of water bearing gravel below the bottom of the well. The water is 24 ft. in depth and will supply 4,000,000 gallons daily. From this well the water is pumped into an elevated reservoir, holding 100,000 gallons. The domestic pressure is 40 lbs., obtained from the reservoir; the fire pressure is derived from direct pumping, the reservoir being cut off. The pumping is done by two compound duplex pumping engines, 14 in. by 20 in. steam cylinders, 11 in. water cylinders and 15. in. stroke; they were made by Fairbanks, Morse & Co., of Chicago.

The distribution is by 7¾ miles of cast iron pipe, 12, 10, 8, 6 and 4 in., with 84 hydrants. The population supplied is 10,000; the works were completed Nov. 1st., and formally accepted on Nov. 7, 1884. Fairbanks, Morse & Co. furnished the engines, boilers, tank and connections; Dennis Long & Co., of Louisville, Ky., supplied the pipe; the hydrants are from the Chapman Valve Mfg. Co.; and the street valves are from Galvin Bros., Detroit, Mich. The original franchise for building these works was secured by Mr. M. M. Moore, of Fairbanks, Morse & Co., and with the exception of the portion before named, the works were constructed by the Water and Gas Works Construction Co., of Pittsburgh, Jas H. Harlow, President and Geo. R. Harlow, Engineer in charge of construction. Mr. Moore was engineer for Fairbanks, Morse & Co. The contract price was $80,000 in the bonds of the Water Co.

NEWS OF THE WEEK.

Contracting.

A $100,000 dredge is being built by the Phosphate Mining Company, of Charleston, S. C.

Philadelphia Sewer.—A main sewer is to be built on 33rd St. between Master St. and Penna. avenue.

Dredging at Edenton, N. C.—Proposals will be received until Jan. 23d, for about $2,000 worth of dredging. Apply to Capt. F. A. Hinman, Norfolk, Va.

N. Y Mining Stock Exchange.—NEW YORK, Jan. 9.—The Building Committee of the New York Mining, Stock and National Petroleum Exchange have drawn up plans for their new building. It will be on Broadway. The ground will cost $700,000 and the building $500,000.

Chicago Buildings.—During 1884, $22,000,000 was built into Chicago structures and $15,000,000 invested in real property lying within the city limits.

New Bridge.—The county of Hamilton will build a bridge across the Tennessee river at Chattanooga. The cost will be about $250,000.

Building Stone.—Anderson & Hobby of 68 Johnson Block, Cincinnati, O., will receive proposals until Jan. 27th for delivering 5,000 cu. yds. of building Limestone at Ivorydale, Hamilton County, O.

U. S. Dredging.—Bids will be received until Jan. 26, by Capt. Thos. N. Bailey, U. S. Eng., of Charleston, S. C., for dredging on the bar in Wappoo Cut, Charleston Harbor and in Ashley River.

Ship Building on the Clyde.—The various shipbuilding firms on the Clyde launched last year 319 vessels, of an aggregate tonnage of 296,855 tons, being a falling of in tonnage of 122,810 as against 1883, of 95,080 tons as compared with 1882, and of 44,168 as compared with 1881. This result was only to be anticipated from the complete collapse in shipbuilding which set in toward the close of the year.

Repairs to New York Bulkheads and Piers.—Bids received at the Department of Docks, N. Y., until Jan. 21., for repairs to crib bulkheads on Rivington Street, East River, and to pier 61, East River. *Also for repairing* Hospital Pier at Wards Island, until same date.

Steam Heating for New York Public Buildings.—It is said that the Secretary of the Treasury is about entering into a contract with the American Steam Heating Co., of New York, for so heating the public buildings in this city.

Brady's Tunnel, on the Hempfield extension of the Balt. & Ohio, to Connellsville, Pa., will be ready for the ties in a few weeks. Work was first commenced on this tunnel in 1853, resumed in 1873, then suspended and again commenced in 1881.

Welland Canal.—There is a strong opposition in the Canadian Parliament to the vote of $1,000,000 for deepening the Welland Canal to 14 ft. These canals are said to have already cost the Government $40,000,000. Quebec wants the ship canal from there to Montreal deepened first, and Montreal sides with Quebec.

Mississippi Levees.—The Levee Board of the First District met at Austin, Tunica County, Miss. Jan. 5th, and reports were presented showing that about 80 per cent. of the levees under contract have been finished, except the one between Austin and Trattor's Landing, measuring 400,000 cubic yards. This is progressing very slowly.

Electric Light in London.—The city of London has not yet given the electric light a thorough test, but a company has now taken the contract to light a square mile of the city, with the Royal Exchange as the centre, at the price now paid for gas, and to light the Mansion House for the additional sum of $5,000 a year.

Bids for N. Y. Suburban Rapid Transit Bridge and Viaduct.—The following bids were received Dec. 17 and 30, 1884: J. J. R. Croes, Chief Engineer, Theodore Cooper, Consulting, Engineer.

SUPERSTRUCTURE OF HARLEM RIVER DRAW BRIDGE. ONE PIVOT SPAN OF 244' 6"—TWO FIXED SPANS OF 101'-10½"

Estimated weight of wrought-iron..... 950,000 lbs.
Estimated weight of cast-iron..... 35,000 lbs.

	Bidders.	Cents per pound. Wrought Iron.	Cast Iron.	Aggregate Bid for Iron Work
1	New Jersey Steel & Iron Co	3 985	4 655	39,486 75
2	Morse Bridge Co	4 09	3 74	40,164 00
3	Union Bridge Co	4 15	4 15	40,877 50
4	Phœnix Bridge Co	4 20	3 90	41,265 00
5	Passaic Rolling Mill	4 16	5 495	44,443 25
6	R. F. Hawkins Iron Works	4 25	3 25	41,512 50
7	C. J. Schultze	4 35	6 00	43,425 00
	Alden & Lassig	4 48	4 48	44,128 00
9	Riverside Bridge & Iron Works	4 57	8 00	46,215 00
10	Pittsburgh Bridge Co	4 90	7 00	49,000 00

ELEVATED FOUR TRACK VIADUCT NORTH OF HARLEM RIVER.

Plate Iron Girders..... 900,000 lbs.
Channel Iron Columns..... 100,000 lbs.

	Bidders.	Cents per pound. Girders.	Columns.	Aggregate Bid for Iron Work.
1	Alden & Lassig	3 247	4 247	33,470
2	Passaic Rolling Mill	3 54	3 54	35,400
3	Phœnix Bridge Co	3 55	3 55	35,500
4	Union Bridge Co	3 60	3 60	36,000
5	Pittsburgh Bridge Co	3 58	4 45	36,670
6	C. J. Schultz	3 90	3 45	38,550
7	Boston Bridge Co	3 88	4 38	39,300
8	Morse Bridge Co	4 00	4 00	40,000
9	Cofrode & Saylor	3 95	5 25	40,800
10	J. B. & J. M. Cornell	4 20	4 20	42,000

Iron Works—Toledo, Ohio.—The following is an abstract of the bids for iron roof, attic floor beams, &c., of the custom house, &c., at Toledo, Ohio:

Phœnix Iron Company, Trenton, N. J., $22,987.50.
Snead & Co., Iron Works, Louisville, Ky., $19,900.
Bartlett, Haywood & Co., Baltimore, Md., $22,658.
Haugh, Ketcham & Co., Indianapolis, Ind., $17,475.
Clark, Ruffin & Co., Chicago, Ill., $28,893.

Kansas City, Mo.—Messrs. Erath & Freilinger, of Kansas City, Mo., have been awarded the contract for the wooden block pavements of the Kansas City custom house, &c., at their bid of $1,992.41.

Messrs. Hughes & Dugan, of Kansas City, Mo., have been awarded the contract for stone work of the approaches of the Kansas City custom house, &c., at their bid of $2,380 for flagging, &c., of Fort Collins sandstone.

New York Canals.—Representative Rogers of Buffalo introduced into Congress on Jan. 12th, a bill authorizing the Secretary of the Treasury to issue to the State of New York, on the credit of the United States, $8,000,000 3 per cent bonds. The State of New York to first pledge itself to the enlargement of the aqueducts and one tier of locks of the Erie & Oswego Canals, to pass vessels 25 ft. in width and 100 ft. long. The work to be done under the U. S. Engineers. Bonds to be issued as the work progresses.

A German bid for the Galveston Jetty.—WASHINGTON, D. C., January, 7.—Herr Edward Romer, an eminent engineer of Prussia, is here with a proposition to improve Galveston Harbor. He is indorsed by such men as Gen. Silas Seymour, Gen. Terrell and Col. Cook Talcott. He has made an examination of Galveston Harbor and he proposes to do the work contemplated in the proposition of Capt. Eads for $4,500,000, about one half what the American engineer asks. He brings with him elaborate drawings and estimates to demonstrate to Congressmen that he knows what he is talking about.

Iron Work—Pensacola, Fla.—The following is a synopsis of the bids for iron columns, beams, girders, &c., for the custom house, &c., at Pensacola, Fla:

Stewart & Sheriff, Richmond, Va., $10,448.
McHose & Lyon, Dayton, Ohio, $10,000.
Phœnix Iron Company, Trenton, N. J., $10,750.
J. Cosgrove, Pensacola, Fla., $5,375. Bid informal; on columns only.
Snead & Co. Iron Works, Louisville, Ky., $9,869.
T. H. Brooks, Cleveland, Ohio, $10,950.
Bartlett, Hayward & Co., Baltimore, Md., $9,370.
J. B. & J. M. Cornell, New York city, $8,973.
Jos. Hall & Co., Richmond, Va., $9,550.
Post & McCord, New York city, $9,130.
Haugh, Ketcham & Co., Indianapolis, Ind., $7,942.80.

Miscellaneous.

Madison, Ind., is petitioning Congress for a new public building to cost $75,000.

Massachusetts State Map.—The new topographical survey and map of the State of Massachusetts on the scale of two inches to the mile is well under way, and will be completed, it is estimated, in about four years.

The London American Exhibition of 1886.—The syndicate formed to organize the American exhibition in London, which is to be opened in May, 1886 has been merged into a private company, with a capital of $500,000. Lord Ronald Gower is Chairman of the new company.

The Pacific Coast Land Bureau has recently effected the sale of a large tract of railroad land in the neighborhood of Elko, Nev., to a Scotch syndicate. The price to be paid is $1,500,000. The sale embraces an area of 520,000 acres with 25,000 head of cattle thereon.

The Coke Interest in Penna.—The Kemble Iron Co., which has recently acquired the property of the defunct Kemble Coal & Iron Co., of Penna. has a total capital of $950,000. It proposes to at once put the furnaces at Riddlesburg, Pa., into operation.

The Sanitary Improvement of Naples.—The Roman Senate adopted on Jan. 11th, by a vote of 96 to 21 a bill, for the sanitary improvement of Naples. A million francs will be expended on the work in the next ten weeks. The Government will supervise the work, and guarantee a new city loan.

Gibbs & Co., Portland Cement.—The well-known Portland cement of Gibbs & Co., Limited, England, has now an agency in New York City, being there represented by Mr. Howard Fleming. 50,000 tons of this cement have been used in the Liverpool Docks, 10,000 tons in New Haven Harbor, and 5,000 tons in the Quebec Docks. This cement is noticeable for extreme fineness and great strength.

The Indianapolis Rolling-mill Company at their annual meeting next week will seriously consider the converting of the new steel rail mill into a mill for manufacturing heavy structural work. When in all probability there will be a gradual increase in the demand for rails from this time forward, it must of necessity be slow, and it will be several years before the high tide of 1882 is again reached, if it ever is.

Consolidating Gas Companies.—PITTSBURG, Jan. 10—The several natural gas companies of Western Pennsylvania are about to consolidate their interests and assisted by eastern capitalists, will organize the Seaboard Natural Gas Company. It is proposed to transport natural gas to Philadelphia, New York, and other Eastern cities. Work will begin not later than May 1. A Greensburg telegram says that in the last few days a great amount of gas territory has been bought up. To-day at least three-fourths of a tract of 500,000 or more acres of gas producing territory in Western Pennsylvania is tied up in leases held by enterprising companies.

Progress of the New South.—The Baltimore *Manufacturers Record* of January 8th, in its annual review of Southern Industries, publishes a list of all manufacturing and mining enterprises organized in the Southern States during 1884, giving the name, location, and character of business of each. The list shows 1,865 new enterprises, with an aggregate capital reaching the enormous sum of $105,269,500. The list shows that almost every branch of general manufactures is represented. Cotton and woolen mills, machine shops, foundries, blast furnaces, ice factories, saw mills, planing mills, building material factories, furniture factories, carriage and wagon factories, handle factories, etc., are very numerous. There are many flour mills and more tobacco factories, and a large number of cotton-seed oil mills, as well as mining enterprises of all kinds, gold, silver, copper, mica, ore, coal, etc. A noticeable feature is the amount of Northern and Western capital going into the South, though the southern people are themselves showing remarkable energy in developing their resources.

Ohio Legislation.—Bills were introduced at Columbus on the 9th inst. as follows:

Mr Williams—Authorizing the Commissioners of Belmont County to borrow $50,000 additional to complete the Court-house.

Mr. Stryker—To make the sewerage law non-operative in Hamilton County where sewers run through private property. Repealing the section providing that assessments for sewers on private property be assessed the same as on public highways.

Mr. Littler—Authorizing Springfield to build additional sewers.

Mr. Burnett—Compelling all railroad companies operating railroads to use automatic couplers on all freight cars, the style of coupler to be recommended by the State Supervisor of Railroads.

Mr. Thompson, of Hamilton—Abolishing the office of County Engineers in Hamilton County, and limiting the payment of employes of the Hamilton County Commissioners to $10,000 per annum.

Mr. Meyers—Authorizing the Franklin County Commissioners to levy tax to build a bridge at Dublin at an expense not to exceed $40,000.

Mr. Addison—Authorizing Muskingum County Commissioners to build bridge.

Railroads, Bridges and Canals.

Washington & Richmond R. R.—Another line is to be constructed to connect Washington, D. C., and Richmond Va. The company has been organized under the title of the Richmond and Washington City Railroad.

The Brooklyn Elevated Railway laid the first rail on Jan. 9; the completion of the road is now to be pushed. The fare will be five cents.

British Columbia R. R.—Mr. Dunsmuir and Gen. Charles Crocker of the Southern Pacific Railway have been awarded a grant of 750,000 acres to build what is known as the Island Railway, a line seventy miles long reaching from Nanaimo to Victoria.

The Canton Iron Bridge Co., of Canton, O., has received a contract to erect six iron bridges over different streams in Gilmer Co. W. Va. Their bid was a fraction over $13,000 for the entire work, and the same to be completed before July 1st, 1885.

R. R. Stocks & Bonds.—The sales of railway bonds on the New York Stock Exchange, in the year 1884, amounted to $499,955,200. The sales of railway bonds were the largest in January. In May, also, there were large sales.

The number of shares of railway stock sold during the year 1884, on the New York Stock Exchange, was 95,667,668, against 96,500,000 in 1883, 116,700,000 in 1882, 117,000,000 in 1881, and 97,000,000 in 1880.

Bridging Staten Island Sound.—Bills before Congress, favorably reported by the Commerce Committees of both the House of Representatives and the Senate, authorize the construction of two bridges across Staten Island Sound, one at Elizabethport and the other at Perth Amboy.

The Portage Canal.—Secretary Lincoln has sent to the Senate a report of Lieut. Col. Poe on the Portage Lake & Lake Superior Canal. The document is a very long one, but is in substance that though the canal has cost $3,000,000 the United States can buy it for $350,000, with no liens or claims against it.

Virginia's New Canal.—PETERSBURG, VA., Jan. 10.—The Upper Appomattox River Canal, from here to Stony Point, in this State, a distance of 85 miles, has just been completed. The canal is owned by a syndicate of capitalists of this city, by whom it was purchased some months ago at a cost of $60,000.

The Northern Pacific Bridge across St. Louis bay, between Duluth and Superior, when completed will be one of the greatest railroad bridges in the Northwest. It will be nearly one mile in length, and will be composed of three sections. The draw will be 256 feet long, the fixed truss span 160 feet, and the pile-bridging 4,290 feet, making the total length 4,696 feet.

F. E. & M. R. R. R.—The contract for laying the steel surfacing track, and finishing, ready for running trains from Valentine to White River, was let Jan. 3, 1885, to T. E. Kelly of Michigan, who is to commence laying steel not later than April 15th and is to have track completed to White River, Neb., by August 1, 1885. Distance 141 miles.

Market Wagons by Rail.—The garden-truck train of the Long Island R. R. made a second experimental trip of 21 miles on Jan. 13, 22 wagons were carried on 11 flat cars. The run was made in 1½ hours, and it took 35 minutes to unload. The charge for each team for the round trip was $4.

Argentine Railroads.—In the Argentine Republic there has been built and is now in operation a railway mileage of 3,641 kilometors, or 2,400 miles; 1,000 miles more is under construction, and another 1,000 under survey. The telegraph lines amount to 10,000 miles, nearly all owned by the Government. The stage lines employ 11,000 horses.

Mt. Kearsarge R. R.—The preliminary survey of the Mount Kearsarge Railroad N. H. has been completed as far as the highest point of land between Mount Kearsarge and the next mountain. From this point it is proposed to run the road spirally to the summit, and probably supplement the main road by a branch to Chatham, starting from the aforesaid terminus of this year's survey.

Steel Rails.—The productive capacity of the steel rail mills of the United States is about 1,600,000 tons per annum. About 600,000 tons went into new lines last year, and the amount used on renewals, new second track and sliding is estimated as 650,000 tons, or 5.42 per cent. of the total amount of rails in track. At the end of 1883 a little more than half the track of the United States was iron.

New Lines in the Northwest.—ST. PAUL, Jan. 11.—Negotiations have been completed for the sale of the James River Valley Road to Crawford Livingston, of St. Paul, and President Merriman, of the Merchants' National Bank, also of this city. No figures are given. It is said that the purchase is made in the interest of the Rock Island system. The line is to run from Jamestown south and through Southern Dakota from east to west.

It is stated on good authority that the Dominion Government and the Canadian Pacific have completed negotations for the construction of the Manitoba Southwestern Railway through Southern Manitoba.

Suez Canal.—The Anglo-French Engineer Commission has decided to give the Suez Canal a breadth of 220 feet and a depth of 27 feet. The cost of the improvement is estimated at $40,000,000.

The Indiana & Illinois R. R. has been abandoned as not paying operating expenses. The road is narrow gauge, 100 miles long, and runs from Effingham, Ill., to Switz City, Ind.

A National Railroad Commission.—Captain R. S. Hayes, senior vice-president of the Missouri Pacific Railroad, thinks that a remedy for the present railroad trouble is the appointment of a national railroad commission, to consist of a practical railroad man, and an attorney familiar with railroad affairs and some third person. A commission could decide on all questions of parallel lines, rates, etc., with justice to all. He thinks the roads rife for such action in Washington, and would not be surprised if a bill for the creation of a national railroad commission was brought before Congress at the next session.

Boston's Railway Travel.—Boston exceeds all other cities in the country in the extent of its suburban railway business; although the total mileage is only 2600, the passenger traffic is immense. During the year the nine roads running out of Boston, carried 51,583,211 passengers, an increase of 4,389,812 over the previous year. Of the total number, two-thirds were taken to and from Boston. Although the city has increased in population during the year, it is a curious fact that the railroads carried out over 225,000 more people than they brought in. This, however, is partly accounted for by the emigration travel which entered the city by steamer and left for the West and South by rail.

Mexican R. R. Notes.—A consignment of material destined for the Merida tramways, Yucatan, has arrived by steamer from New York to Progresso. Waldemaro G. Canton is the concessionaire, and he states that work begins in a few days on the said tramway, the first division of which to be laid is that from the Independencia Plaza to the General Cemetery.

The people of Tekax and Ticul intend to lay out a wagon road from Ticul to the Hunachen hacienda, where the Merida-Peto Railroad will establish a station. The distance of the road is nine miles, and it will unite the towns of the southern part of the State with the railroad to Merida.

It is stated now that the Morelos Road is to be continued. One thousand tons of rails are expected in Vera Cruz soon.

Engineer Manuel Marin has arrived at Mazatlan to survey the ground for the railroad to unite Mazatlan with Rosario. This scheme has been fostered by Gen. Francisco Canedo, the Governor.

The Mersey Railways.—The whole length of the tunnel under the River Mersey, which is 1300 yards from quay to quay, is now arched in, and the greater part of the land approaches are finished, so that the laying of the permanent way will shortly commence. The total length of the line will be 4¼ miles, independent of some extentions now being proposed. It runs from the London and North-Western and the Great Western joint lines at Birkenhead, to the Central Station at Liverpool, the course being chiefly under the public streets in the land portion. The undergound parts of the stations at Green-lane, Tranmere, and Hamilton-square, Birkenhead, with that at James street, Liverpool, are in a forward state. The hydraulic machinery for lifting trainloads of passengers, the machinery for mechanical ventilation, and the locomotives and carriages are in course of manufacture. It is expected that the railway will cost half the mileage rate of the Metropolitan Railway, and that the main line of three miles will be opened about June next. The engineers are Messrs. J. Brunlees and C. Douglas Fox; the contractors are Major Isaac and Messrs John Waddell and Sons.

A Device to Increase the Power of an Engine.—A newly patented device for increasing the traction of freight engines was tested Jan. 7, on the Rochester and Pittsburg Road. It is claimed that it holds the engine from slipping and saves rocking. It is a leverage arrangement by which the weight of the tender is thrown upon the engine, to which is attached two strong iron bars. This, it is said, adds 25,000 pounds to the tractive power, making a common four-wheel engine equal to a "mogul" or a "consolidated" engine. The engine making the test is a new one of forty-two tons weight. Superintendent Gardiner resolved to give them a severe test upon the hardest grades of the road, and attached the engine to fifty-six empty cars, which were equally as difficult to haul as twenty-eight loaded cars.

The first grade was a long one at West Seneca of fifty-five feet to the mile on a straight track and was passed over very nicely without a single slip. The next was this side of Titus Hill, sixty-two feet to the mile and on a very bad curve. Engineer James Brennan held on nobly, but the engine stalled. There was a wet track and a side wind. The engine held to the track so tenaciously that not until it stalled did it slip in the least. Superintendent Gardiner considered the test a very satisfactory one. He said an engine without the attachment could not possibly do the work.—*N. Y. Times.*

The N. Y. & Boston Inland R. R. commenced construction at East Medway, Mass., on Jan. 10.

A New Central American R. R.—Capt. J. P. Nelson started on Jan. 3, for the Republic of Guatemala, where he has a contract to build the *Ferro Canil del Norte de Guatemala*. The road is to run from Puarta Barrico, on the Gulf coast, to the city of Guatemala, distant 240 miles, and thence to the Pacific coast 71 miles.

An East River Tunnel.—It is stated that an agreement has been arrived at whereby, upon the completion of a tunnel under the East River, at Blackwell's Island, to a point in Ravenswood near Hunter's Point, the Long Island R. R. Co. will be permitted to use the tracks leading into the 42nd, St. Grand Central Station. It is rumored that work will commence at an early day upon the tunnel.

New Penna. R. R.—It is said the Pennsylvania Railroad contemplates the building of a line from Willow Creek, Berks County, to Allentown, connecting with the Lehigh Valley Road, and forming a new route from Reading to New York, via Allentown, Easton, and Metuchen, on the Lehigh Valley Road, thence over the Pennsylvania Road to Jersey City. The preliminary surveys are being made, and the route passes through a rich country, almost parallel with the East Pennsylvania Road.

A New Pacific Railroad.—A contract has been closed by the American and Mexican Pacific Railroad Company for the construction and equipment of the first section of their road, commencing at the harbor of Topolobampo, on the Gulf of California. James Campbell, who was for many years Superintendent of the Central Pacific Railroad Company, has been appointed General Superintendent of the American and Mexican Pacific Railroad Company, and he leaves to take charge of the work at Topolobampo.

Electro-plated Railway Cars.—London *Engineering*, of Jan. 2, contains an illustrated description of a railway carriage built by the South Eastern Railway Co., of England. The noticeable feature is in the electro-plated steel panelling and electro-plated copper moulding. The panels are $\frac{1}{8}$ in. thick and the mouldings are sheet copper; the frame is angle iron in combination with wood. The under frame is entirely of iron. In the model car built the plating is silver, but nickel plating or Stranno-steel it is thought, would cost little more than such a car several times painted.

Survey of a R. R. Line from Parkersburg to Clifton Forge, Va.—A complete and accurate survey of a R. R. line from Parkersburg up the Little Kanawha River and through to Clifton Forge, Va., has just been completed. The line crosses the entire breadth of W. Va., and intersects a region of timber, iron and coal superior to any in this part of the U. S. Within the last month a tin mine, reported by reliable parties to be in large paying quantities has been discovered on the proposed line in Calhoun County. It is expected that 100 miles of the above road will be under contract before the close of 1885.

Russian Railway Notes.—The Russian Minister of war has lately signed a contract for steel rails to the value of $745,000, to be used in laying a railway from Kizil Arvat to Askabad, on the way to India.

The same Minister has also ordered 140 locomotives from the Kolonuma Works, at £3,100 for the first half and £3,000 for the second half, each.

A Russian Commission has recommended that the rolling stock of the Transcaucasian Railway, used in oil transport between Baku and Batoum, be increased by 58 locomotives and 750 tank cars.

The Russian Minister of Railways is about commencing the construction of the Novorossick R. R. It will run from Novorossick, on the Black Sea to Petrovsk, on the Caspian Sea; it will be 172½ miles long and cost $7,000,000, including $750,000 for the improvement of the port. The gauge will be 5 ft., single track.

Control of the Broadway Railroad.—The effort of *The Commercial Advertiser*, under the heading of "Broadway in Danger," to make it appear that a Philadelphia syndicate is on the point of taking possession of the great thoroughfare, has failed to arouse the public to a realizing sense of any greater jeopardy in that direction than was already threatened by the Broadway Surface Railroad Company. It is said that P. A. B. Widener, President of the Philadelphia Traction Company; J. H. Elkins, and William H. Kemble have been making an effort to obtain the Broadway franchise, but this statement lacks confirmation. Those connected with Jacob Sharp's Broadway Surface Railroad, and those who speak for the Broadway Railroad Company, of which James A. Rossevelt is President and William C. Whitney a leading projector, alike deny that any steps have been taken toward selling their not yet acquired franchises to the Philadelphia people. There seems to be little doubt that Mr. Sharp's party will construct the road if it can obtain the right to do so.

The New York Cable Railway Company has yielded its claims upon Broadway and has not yet obtained permission to build upon other streets. When it does so, its projectors say its roads will be built and operated without assistance from any Philadelphia syndicate.

Market Report of Engineering Materials.

New York, January 15, 1885.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.			
STRUCTURAL IRON.			
Angles	2.3c.	@	2.6c.
Bridge plate			
Tee	2.8c.	@	3c.
Beams and channels	3.5c.		
Tank	2.2c.	@	2.3c.
Shell	2¾c.		
Steel plates, Tank	3c.	@	3½c.
WROUGHT-IRON PIPE.			
Butt welded, black ... Discount	45	50	%
" " galvanized ... "	35	@	%
Lap welded black ... "	65	@ 05	%
" Galvanized ... "	45	@ 05	%
Boiler tubes ... "			
RAILS.			
Steel (large lots at mill)	$28	@ 30	
Old rails	16.50	@ 17 50	
Old steel rails	16	@ 17	
R. R. spikes			2c.
R. R. splice-plates	1.65c.	@	1.75c.
R. R. Track Bolts	2¾c	@	2¾c.
Barb-wire fencing, galvanized			5c.
" painted			4c.
Corrugated iron			
BRICK.			
(Cargoes afloat)			
Haverstraw 1st ... per M.	$6.00	@	6.12½
" 2nd ... "	5.50	@	5.75
Fishkill	4.75	@	5.50
Up-River	5.00	@	5.50
Jerseys	4.50	@	5.50
Long Island	5.50	@	5.75
" pale	3.00	@	3.25
FRONTS.			
Croton red	14.00	@	15.00
" dark	14.00	@	15.00
" brown	13.00	@	14.00
Philadelphia pressed	22.50	@	23.00
Trenton "	22.00	@	23.00
Baltimore "	37.00	@	41.00
Buff "	33.00	@	35.00
Enameled English	65.00	@	130.00
" American	85.00	@	120.00
Fire brick	25.00	@	35.00
CEMENT.			
PORTLAND.			
Robins & Co., Extra English 425 lbs	2.75	@	2.80
K. B. & S. English 400 lbs	2.65	@	2.80
Burham " "	2.50	@	2.60
Rochester Castle " "	2.50	@	2.60
J. B. White & Bro. " "	2.50	@	2.60
Other brands, " "	2.40	@	2.50
Keene's fine " "	9.50	@	9.75
" course " "	5.25	@	5.50
Roman	2.75	@	3.50
Dyckerhoff, German 400 lbs	2.60	@	2.65
Star, " "	2.60	@	2.65
Alsen, " "	2.55	@	2.60
Hanover " "	2.40	@	2.50
Other brands, " "	2.35	@	2.40
Saylor's American	2.15	@	2.50
Rosendale cements	0.90	@	1.00
LIME.			
Rockland common per bbl	1.00		
" finishing	1.20		
Glensfalls, common	.85		
" pointing	1.05	@	1.10
Kingston, ground	0.95		
STONE.			
Cargo rates at New York.			
Amherst freestone, No. 1 per cub. ft	0.90	@	1.00
" " No. 2 "	0.75	@	0.80
" " light drab "	0.80	@	0.95
Berlin " in rough "	0.75	@	1.00
Berea " " "	0.75	@	1.00
Brownstone, Portland, Ct. "	1 00		
" Belleville, N. J. "	0.75	@	1.25
Granite, rough	0.60	@	1.25
Common building stone per load	2.00	@	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40	@	3.00
SLATE.			
Purple roofing per square	6.00	@	7.00
Green "	6.00	@	7.00
Red "	15.00		
Black Penna. (at New York) "	4.50	@	5.00
LUMBER.			
PINE, Common box per M.	18.00	@	20.00
Good "	55.00	@	60.00
Tally plank, 1¾ in each.	.44	@	.50
Tally boards, dressed "	.28	@	.30
SPRUCE, Boards dressed "	.25	@	.28
Plank, 1¾ in "	.28	@	.30
" 2 in. "	.38	@	.40
" 2 in. dressed "	.43	@	.45
Timber per M.	20.00	@	22.00
HEMLOCK, Boards each.	.18	@	.20
Joist, 2½ × 4 to 4 × 6 in	.17	@	.44
OAK per M.	55.00	@	65.00
CYPRESS 1, 1¼, 2 and 2¼ in "	35.00	@	40.00
YELLOW PINE, Girders "	26.00	@	35.00
Dressed flooring "	30.00	@	40.00
SHINGLES, Extra shaved pine, 18 in. "			
" sawed " 18 in. "	4.50	@	5.00
LATH, Cargo rate	2.50	@	2.60
PAINT.			
Lead, white, American dry per lb.	.04¾	@	.05
" " in oil pure "	.05½	@	.05¾
English, B. B. in oil "	.08½	@	.08¾
Red, American "	.05½	@	.05¾
Litharge "	.05	@	.05¼
Venetian red, American "	.01	@	.01¼
Indian red "	.05	@	.10
Vermillion, American lead "	.11	@	.11¼
Paris green "	.15	@	.19
Umber, Amer. raw and powdered "	.01¼	@	.01½
Drop black, Amer "	.08	@	.12
" " "	.09	@	.11¼
Chrome green	.05	@	.15
Oxide zinc, American	.03¾	@	.04
" " French	.06¾	@	.06½